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Barry Bloom**



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Right now, you're reading *High Technology Business*, the most comprehensive magazine devoted to high technology and its impact on business and investment. At press time, this issue was as up-to-date and relevant to current market and business conditions as possible. But "high technology" is such a dynamic field, there's something new happening every single day. So we invite you to keep up with late breaking developments by watching the *High Technology Business Minute*, on Financial News Network, television's leading source for business and investment news.

In addition to the breaking news, we offer interviews with leaders and experts in high technology business. So for in-depth analysis and interpretation of trends, keep reading *High Technology Business*. And for the latest scoop on high technology business, watch the *High Technology Business Minute* at 1:45 PM and 4:50 PM ET, weekdays on FNN.

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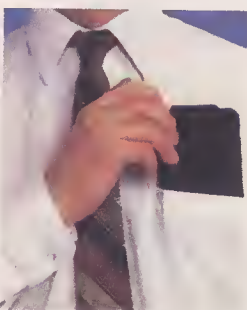
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HIGH TECHNOLOGY BUSINESS

FEATURES

18

CASH CRISIS CREATES BIOTECH ALLIANCES

The disappearance of equity financing has put new pressure on small companies to link up with larger ones—or risk failure.

25

TV: THE PUSH FOR A SHARPER PICTURE

As fighting rages over the home market, producers are already using high-definition systems.

32

NEW PAGERS PUT A MAILBOX IN YOUR POCKET

No mere beepers, alphanumeric pagers take detailed messages and tap into on-line databases.

39

COMPANIES PROFIT FROM SOUNDS OF SILENCE

Active noise-control products are on their way to help quiet cars, planes, and power plants.

44

DESIGNWARE LEADER FACES NEW THREAT

Companies offering a new twist in computer-aided software engineering are challenging the top player.

48

INTERVIEW Lockheed chairman

Lawrence Kitchen discusses the problems of defense contractors.

COLUMNS

13

COMPUTERS Apple's push into offices everywhere will change the face of corporate computing.

15

JAPAN WATCH The mainframe-computer market puts new emphasis on specific uses.

17

THE LAW When buying a technology

company, remember that what you see isn't always what you get.

MARKETWATCH

30

THE LEADING 100 A guide to high-technology stock performance.

57

NEW COMPANIES An update on where the startups are.

58

CONTRACTS AWARDED A record of companies and how much they'll make.

60

MERGERS & ACQUISITIONS Who's buying whom and for how much.

61

JOINT VENTURES The collaborations that are shaping the future.

62

RESEARCH REPORTS The latest studies for businesses.

DEPARTMENTS

5

EDITOR'S NOTE

6

LETTERS

8

NEW DEVELOPMENTS Answering machines talk without tapes; biosensors find fresh uses.

53

NEW PRODUCTS Computer hardware and software, manufacturing equipment, and consumer items.

63

COMPANY INDEX

64

PERSONAL TECHNOLOGY Steering wheels with extra controls; faucets that "see"; a chair for listening.



Biotech firms seek creative financing sources, p. 18.



New pagers deliver messages anywhere, p. 32.



Upstart contenders take on Index Technology, p. 44.

Cover photographs by Walter Bibikow

Back By Popular Demand.

At one time, peregrine falcons nested by the thousands throughout the United States. But with the widespread use of the insecticide DDT in the 1940s and 1950s, the species suffered greatly. In the eastern U.S., the peregrine falcon disappeared entirely.

Now peregrine falcons have made a comeback, thanks to efforts by conservationists.

Since 1975 when recovery programs were established, 752 peregrines have been released in the eastern U.S., and there has been a steady increase in the nesting population.

With wise conservation policies, other once rare species such as the American alligator and the bald eagle have also made comebacks.

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Biotechnology's Double Play

THE BIOTECHNOLOGY industry is still in the toddler stage. Despite many optimistic forecasts about the potential for new products created by genetic engineering, those products are only beginning to reach the market. Some analysts predict that biotechnology may eventually become not a separate industry, but a collection of techniques to be adapted and used by other industries such as agriculture and chemical processing.

Whatever its destiny, at the moment biotechnology is particularly vulnerable to the demands of cash flow. Without products on the market to generate revenue, companies have had to pay almost as much attention to raising money as they have to the technologies they are trying to commercialize.

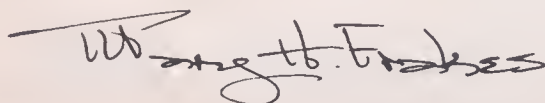
The situation has become acute in the wake of the stock market's weakness; public offerings that could have helped companies remain independent have in many cases been postponed or cancelled.

As a result, biotech companies are increasingly being forced to approach larger companies seeking licensing agreements, partnerships, and joint projects. These arrangements pump cash into the smaller companies and give the larger companies access to technology. Such tactics are not new, but our story by associate editor Fran Lunzer, "Cash Crisis Creates Biotech Alliances" (p. 18), reveals why their pace and scope are likely to increase substantially in the coming months.

The proliferation of joint agreements—and the intertwining of technology and business that they imply—prompted us to photograph two such partners and merge them into our cover photo. Although the combined image of Pfizer Central Research president Barry Bloom and T-Cell Sciences chairman James Grant may be a bit surprising, we hope our illustration of the trend is as dramatic as the potential impact of the trend itself.

This issue also includes an article that outlines the move toward paging systems—"beepers"—that not only alert their wearers that someone wants to reach them, but can deliver the message itself (see "Pagers Put a Mailbox in Your Pocket," p. 32).

Like our cover photo, each story in its own way demonstrates the close link between business factors and technological developments.



Mary H. Frakes

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**HIGH TECHNOLOGY
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■ Superconducting Realities

I ENJOYED reading your January cover story, "1988's Hottest Superconductor Companies." However, please note that at Allied-Signal's Corporate Research Laboratories in Morristown, New Jersey, a small group has been involved in basic research on the new oxide superconductors. In addition, extensive work has been carried out on new compositions and novel processing routes. A number of key papers and reports on this research have been published in international journals.

*Zafar Iqbal
Allied-Signal Inc.
Morristown, New Jersey*

WE COULD NOT have been more pleased to have someone finally recognize the fact that Eriez Magnetics has installed a large, full-production superconducting system in the real world. It appeared that everyone was interested in what *might* happen in superconducting, and very few interested in what was actually happening.

*C.F. Giermak
President
Eriez Manufacturing Company
Erie, Pennsylvania*

YOUR JANUARY article on superconductor companies is of great interest to us at HiTc Superconco. Our company is very active in selling superconductive ceramic powders and parts for practical applications, and has been since April 1987. Our thrust has been in the structural ceramic area with the aerospace and electronic segments key to our growth plans.

Although overlooked in the article, we certainly feel we should be included in any future articles on superconducting. We have accomplished our growth using internal funds only, and have grown rapidly because we are a reliable source of superconductor products that perform. We are not simply a laboratory conducting research and producing test batches of materials, but a company with working production capacity. HiTc Superconco is a subsidiary of Lambertville Ceramic & Manufactur-

ing Co., long a leader in innovative ceramics for industry.

*Richard B. Cass
President
HiTc Superconco Inc.
Lambertville, New Jersey*

■ Bellcore Not Part of Bell Labs

WE READ WITH great interest your January cover story, "1988's Hottest Superconductor Companies." However, we were surprised and dismayed to see Bellcore erroneously referred to throughout the article as part of AT&T Bell Laboratories.

Bellcore was formed by the seven divested regional telecommunications companies to provide research and engineering support for their local operating telephone companies, 22 in all. It is the nation's largest consortium.

When Bellcore was created more than four years ago in the divestiture of AT&T, a few thousand employees left Bell Labs and AT&T to join Bellcore. However, there has never been any kind of affiliation between Bellcore and AT&T or Bell Labs.

*John E. Lucas
District Manager, Media Relations
Bellcore
Livingston, New Jersey*

■ Alternate Fuels

CHRISTOPHER O'MALLEY's article on alternate fuels ("Alternate Fuels Edge Into Auto Markets," December 1987) was interesting but incomplete. No mention was made of a fuel that is less expensive, safer, causes little pollution, and has abundant domestic supplies—compressed natural gas. This fuel is growing in popularity around the world and now powers some 500,000 vehicles.

Compressed natural gas is a 130-octane fuel that has excellent performance characteristics, extends engine life, and lowers maintenance costs. I have used it in my car for seven years and have found it eminently satisfactory as well as very economical.

*R.E. Wyman
Director of Research
Canadian Hunter Exploration
Calgary, Alberta, Canada*

■ Linking Users and Developers

THANK YOU for the time and consideration you showed Cadam Inc. in the article "CAD/CAM's \$800-Million Winners" (January, p. 41). In an ever-evolving industry such as computer-aided design/manufacturing, publications such as yours provide the integral communication link between the user community and the developers of technology.

*Frank Puhl, President
Cadam Inc.
Burbank, California*

■ Morality and SDI

I AM RATHER disappointed that different viewpoints aren't given in articles on controversial issues such as the Strategic Defense Initiative (SDI), which was the subject of "Star Wars: Where the Money's Going" (December 1987). Money, money, money seems to be the key issue here. What the hell does money matter if we're all blown to bits?

I say scrap the whole SDI project and use the money in areas that lean towards disarming the world of all its weapons, offensive and defensive. In the long run, the SDI project will be a total waste of money and may even lead to mankind's annihilation. The Soviets will try to top the SDI efforts and we'll retaliate with something else, etc. etc. It's just a vicious cycle. How about presenting a moral viewpoint on some of these issues?

*Mark Hillion
Ajax, Ontario
Canada*

■ Santa Clarification

WE APPRECIATED the story about our test that analyzes hair to detect drug use (February, p. 8), but Psychomedics is located in Santa Monica, not Santa Clara.

*Rosa Jordan, PR Director
Psychomedics
Santa Monica, California*

We welcome comments from our readers. Address letters to Editor, HIGH TECHNOLOGY BUSINESS, 214 Lewis Wharf, Boston, MA 02110. We reserve the right to edit letters for length and clarity.

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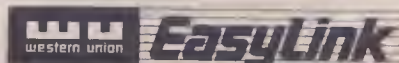
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Answering Machines Abandon Cassettes

ANSWERING machines with solid-state memory should offer better performance than that of traditional machines that use audio cassette tapes.

Cassettes and cassette drives were never designed to handle all the shuttling back and forth an answering machine must do every time it takes a call. New machines from Sharp Electronics and Code-A-Phone replace tapes with solid-state memory, making them easier to use, more flexible, and more reliable than today's devices.

Sharp's FP-M62, already in stores for \$249, holds 80 seconds' worth of incoming messages, enough for five 16-second messages or eight 10-second messages. Tony Bernardo, national sales and marketing manager for Sharp's telephone products, says that 80 seconds is long enough for most users, but admits that "psychologically, it's a problem." The FP-M62 can also send a preprogrammed message to a number and notify a pager that it has received an anticipated call.

Code-A-Phone of Clackamas, Ore., showed the first prototype tapeless machine two years ago and will begin selling its Models 6200 and 6250 late this year. Both machines handle as many as seven incoming messages, but the company won't say

how long each message will be. The devices will cost about \$100 to \$150, according to Paul Newman, vice president of marketing.

Because of their high price and limited message time, these machines will not revolutionize the market overnight. But as the cost of memory drops, solid-state units will become cheaper than mechanical systems. The companies predict that solid-state answering machines will take over the market in the next 5 to 10 years.

Evidence Points to Stealth Spy Plane

LOCKHEED'S Aeronautical Systems Group is reportedly developing a \$10-billion spy plane. The aircraft, designed to replace the aging fleet of nine SR-71 spy planes, will fly as fast as Mach 5—3,800 miles per hour—at altitudes higher than 100,000 feet. The plane will probably use technology created for "stealth" bombers and fighters that will render it invisible to radar.

- Decision-makers feel upbeat about U.S. technology
- Software companies lead the computer industry
- Plastic electrical conductors challenge metal



Sharp's answering machine breaks the cassette connection.

STEVEN MARK NEEDHAM

The Pentagon has not officially acknowledged the development project; analysts deduced its existence by reviewing Pentagon budgets and Lockheed's revenue and employment figures. In the 1986 budget, for example, the Air Force requested \$2.1 billion for a secret program called Aurora. This led industry analysts to speculate that Aurora might represent a new reconnaissance plane, because no such program was then under way.

More recently, industry watchers discovered that the Aeronautical Systems Group, based in Burbank, Calif., will receive more than \$1.1 billion in 1988 government funding that cannot be attributed to any known program. This Lockheed division built the SR-71 and is currently building the F-19 stealth fighter. Also, there are more cars in the division's lot than can be accounted for by employees of known programs, indicating the possible existence of a new and secret project.

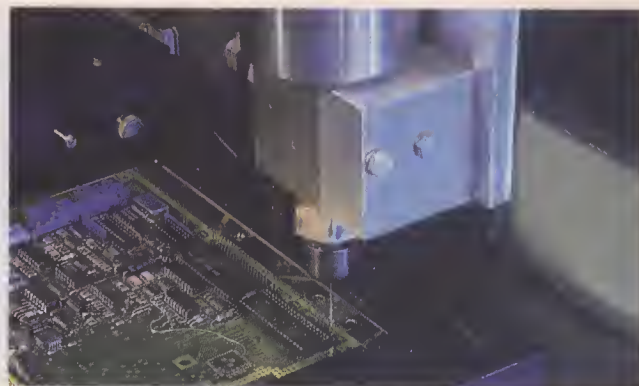
Wolfgang Demisch, an an-

alyst with First Boston, describes the new spy-plane program as "a \$10-billion effort that will build about 30 aircraft." He also notes that there has been no surge of funding at companies that have been promoting new high-speed engine designs, such as Aerojet Techsystems of Sacramento, Calif. Demisch therefore concludes that the plane will probably rely on conventional types of propulsion.

Waterjets Cut Circuit Boards

AS PRINTED-CIRCUIT boards hold more and more components, they become harder to cut into precise shapes without damaging fragile subassemblies. Routers produce dangerous dust, and lasers give off too much heat. The solution: pressurized water moving at twice the speed of sound.

Large-scale waterjet systems are typically used to slice through steel, glass, wood, concrete, and aircraft



DON O'BARSKI

For cutting delicate circuit boards, water is more efficient than lasers.

parts, and smaller waterjet systems have proven an ideal way to cut the delicate circuit boards used in all types of electronic devices.

Flow Systems of Kent, Wash., claims to hold 80 percent of the \$3-million U.S. market for water-powered circuit-board cutters. Ingersoll-Rand of Baxter Springs, Kan., has about a 17 percent market share. A custom waterjet system for cutting printed-circuit boards costs \$120,000 to \$350,000, depending on nozzle size, flow rate, and the pressure required.

Claude Rogers, national

sales manager for Flow Systems, says his company's proprietary technique produces a more consistent cut than other methods. Inconsistent cutting can lead to delamination, or water seeping between the layers of the circuit-board material, which can interrupt the electrical flow and cause the board to fail under stress.

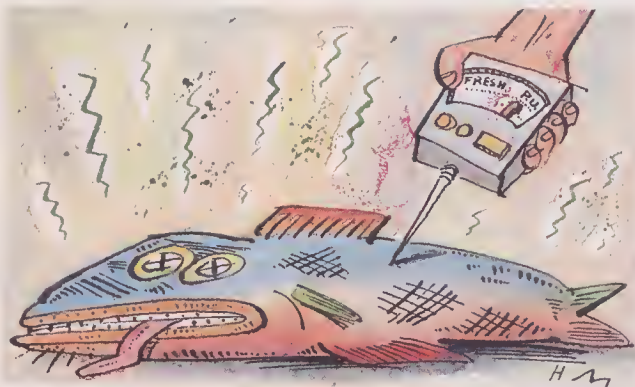
Ingersoll-Rand adds polymers to the water stream to reduce delamination and increase nozzle life. The company recently formed a joint venture with Daiken to sell waterjet cutters in Japan.

Biosensor Business Nets Growth

WHAT DO physicians and commercial fishermen have in common? Both may soon use biosensors in their work.

Biosensors detect and measure chemicals found in living organisms by translating a chemical signal into an electrical signal. Market estimates call for the biosensor business to grow from about \$38 million last year to \$450 million by the year 2000.

That growth will come from a wide variety of areas, from food processing to medicine. For example, when drug-overdose victims are rushed into the emergency



HAL MAYFORTH

room, doctors often must wait for the lab to analyze a blood sample before they can begin treatment. Recent advances in biosensor technology at consulting firm Arthur D. Little of Cambridge, Mass., could lead to a hand-

held device equipped with biosensors designed to detect specific drugs. Using a blood or urine sample, doctors might be able to test for narcotics in just 10 seconds.

Dr. Richard Taylor, manager of the Applied Biotech-

nology Laboratory at Arthur D. Little, says the product could also be used by law-enforcement agencies to detect illegal substances. Taylor says that with outside funding, such a device could be on the market in two years.

In the food-processing arena, biosensors may soon help fishermen tell whether their catch has gone bad. Canpol of Toronto is involved in a number of sensor projects, including a biosensor needle that would give an instant "freshness" readout. The sensor uses an enzyme-coated electrode that measures concentrations of the rancid-smelling substances that begin to accumulate in fish as soon as they die.

Gumming Up Oil Spills

THE SAME ingredient that puts the chew in chewing gum could save millions of dollars in oil-spill cleanup costs. Elastol, a substance produced by General Technology Applications Inc. of Manassas, Va., uses polyisobutylene, a sticky synthetic rubber, to transform oil slicks into a syrupy goo that holds together to speed recovery.

Cleaning up an oil spill involves containing the slick, then removing the oil. To contain the slick, a recovery team stretches five-foot-deep fences, or booms, in the water. The team then uses a vacuum or a skimmer, which



Adding synthetic rubber to oil slicks makes cleanup faster and easier.

works like a giant mop, to remove the oil.

Unfortunately, a spill can spread for hours before the team can erect booms; in the recent spill in the Ohio River, recovery teams took 11 hours to deploy booms. In ad-

dition, skimmers and vacuums often suck up more water than untreated oil.

That's where Elastol becomes useful; the substance makes oil more adhesive, according to a Canadian environmental study. The sticki-

er slick stays in one piece for easier pickup, and Elastol can be sprayed on a slick immediately from a boat or helicopter. General Technology Applications claims that Ohio River cleanup crews could have deployed Elastol within an hour to slow the spread of the slick. The company says the product could help cut oil-spill cleanup time by a factor of 10.

To make Elastol, General Technology combines polyisobutylene with liquid nitrogen, freezes it, and grinds the frozen mixture into a powder. The company then coats the powder with tricalcium phosphate (a calcium additive used in cereal) to prevent sticking, and adds animal fat so it will float.

GENERAL TECHNOLOGY APPLICATIONS INC.

Executives Bullish On U.S. Technology

TWO-THIRDS of U.S. technological decision-makers say they are confident American technology is not falling behind that of the rest of the world. In an exclusive HIGH TECHNOLOGY BUSINESS survey of 988 corporate decision-makers, 66 percent champion U.S. technology over all others. Less than 30 percent think domestic technology has slipped from its preeminent position.

Concerns are mostly confined to specific areas. Of the 285 respondents who say U.S. technology has lost its edge, only 10 percent say the fall has come across the board. Considering the well-publicized troubles of the space-shuttle program, it's not surprising that 15 percent of the pessimistic respondents specify aerospace as the field where the country has suffered most. Other areas frequently named include computers, production, heavy manufacturing, electronics,

Is U.S. Technology Falling Behind?

| | |
|-----------|-------|
| Yes | 28.8% |
| No | 65.8% |
| No Answer | 5.4% |

In What Areas?

| | |
|--------------------|-------|
| Aerospace | 15.4% |
| All areas | 14.7% |
| Production quality | 11.2% |
| Computers | 13.7% |
| Heavy industry | 10.5% |
| Electronics | 8.8% |
| Transportation | 8.4% |
| R&D | 5.6% |
| Scientific R&D | 4.9% |
| Production cost | 3.9% |
| Education | 3.5% |
| Medicine | 2.8% |
| Defense | 2.1% |
| Other | 8.1% |
| No answer | 13.7% |

Note: The figures total more than 100% because some respondents gave multiple answers.

and transportation.

Fewer decision-makers express concern about education, pure science, and R&D, and most were confident about defense technology.

HTI Custom Research conducted the survey for HIGH TECHNOLOGY BUSINESS.

Software Leads Computer Industry

INDUSTRY ANALYSTS predict that the software business will increase by more than 15 percent annually for the next two or three years—about twice as fast as the computer industry as a whole. The analysts attribute this boom to lower prices for both hardware and software, hot industry segments, and strong international sales.

The advent of smaller, more powerful computers has cut the cost of entering the information age, boosting the demand for software. Also, "when hardware costs decrease, software costs

tend to follow," says Peter Burris, an analyst at International Data Corp.

Lower prices make many packaged software programs cheaper to buy than to produce in house. For example, an accounting system that used to take several \$60,000-a-year programmers about 18 months to develop can now be bought off the shelf for about one third the cost. Sales of commercially produced packaged software will reach \$47.35 billion by 1991, up from \$21.84 billion in 1987, according to Standard & Poor's Industry Surveys.

Both the falling dollar and the introduction of packages written with foreign-language interfaces should help spur international software sales. By 1991, about 43 percent of software revenues will come from foreign sales, up from about 35 percent last year. A lower dollar also makes U.S. products less expensive and overseas sales more profitable, says Bahar Gadwani of Kidder, Peabody in New York.

Plastics Display New Abilities

PLASTICS USUALLY insulate other materials, but a variety of chemical and electronics companies are working to create plastics that can conduct electricity. These lighter, stronger, and more durable new materials may some day replace copper in wire, silicon in computer chips, and zinc in batteries, according to a recent report from Technical Insights of Englewood, N.J.

Researchers at Los Alamos National Laboratory in New Mexico have developed

polymers that conduct better than iron, and are taking aim at copper. Several companies are already working on commercial applications.

In Japan, Bridgestone Tire and Seiko have developed a rechargeable lithium battery using a conducting polymer called polyaniline. Japanese sales were slated to begin late last year as a backup power source for personal computers, copiers, VCRs, clocks, and calculators.

In the United States, National Starch and Chemical of Bridgewater, N.J., uses conducting polymers to mold electrodes for use in light-

weight batteries.

BASF of Bridgeport, N.J., which has worked on about a dozen polymer formulas, is experimenting with batteries that could power dictaphones or radios.

Honeywell has developed a transparent conducting-polymer film that it says could be used to defog car windows or help control building temperature by reflecting heat and cold. Long-term uses include solar cells and semiconductors.

Companies also are starting to apply conducting polymers to more immediate projects. Conducting polymers

have been used in product packaging, film keyboards, and electronic equipment. They can also replace metal fillers in conductive adhesives, as well as the metallic contacts in semiconductors.

Allied-Signal of Morristown, N.J., is using conducting polymers to make security seals for packages. The company hides antennas made of metallic paper coated with a conductive polymer beneath fake bar codes. If anyone opens the package during shipping, exposure to air alters the polymer's conductivity. A hand-held monitor alerts shippers to tampering.

ALSO WORTH NOTING



Robots move from factory to field.

■ Robots have traditionally found work in the industrial sector, but researchers in Florida and France have developed experimental robots designed to pick fruit in orchards. France's apple-picking robot, dubbed Magali, is the brainchild of four groups—manufacturer Pellenc en Motte; the National Center of Agricultural Machinery for Rural Engineering, Water and Forestry; the Automatic and Microelectronic Laboratory at Montpellier; and the International Institute of Robotics and Artificial Intelligence at Marseille. The self-propelled robot

uses a three-camera vision system to find the fruit and a vacuum gripper to gently tug the apples off the tree. The U.S. picker, developed by the University of Florida's Institute of Food and Agricultural Sciences, uses a small color TV to find oranges. Italy's Agriculture Industrial Development is funding further research. Both fruit-picking robots are several years away from commercial introduction.

■ A developer of semiconductors has set a new record for solar-cell performance. A photovoltaic device from Kopin Corp. of Taunton, Mass., uses a thin film of gallium arsenide to convert 23 percent of the sunlight that hits it into electricity. In the past, such efficiency has been possible only with cells made from "bulk" crystal. The Energy Department, which sponsored Kopin's research, is focusing its photovoltaic work on thin films because of their potential for high efficiency and economical mass-production.

But because even thin-film gallium arsenide costs much more than the silicon used in conventional solar cells, Kopin sees most potential in high-cost uses such as satellites.

■ As the number of AIDS victims grows, so does the number of companies in AIDS-related businesses. According to the Worldwide AIDS Directory published by Technology Management Group, more than 2,000 organizations are involved in AIDS research, product development, information, tests, and services. The effort includes 786 manufacturing companies, 452 chemical, biotech, or pharmaceutical companies, and 700 universities and research institutes, as well as 388 social-service groups that provide home care, support groups, and legal services. AIDS studies have been conducted by 143 research centers around the world. AIDS activity is expected to bring more than \$3 billion to manufacturers by the mid-1990s.

■ A sensor under development with U.S. Navy funding will detect signs of life at a distance. Researchers at Michigan State University and the Georgia Institute of Technology say the microwave-based system will be used to find wounded soldiers, monitor hospital patients, and watch over babies at risk for sudden-infant-death syndrome. The sensor broadcasts microwaves and detects small changes in the reflection, indicating body movements such as heart rate and breathing, even through clothing. Researchers are working on short- and long-range sensors to detect life from five to several hundred feet away. Not yet perfected, the sensors can be confused by unanticipated movement, including wind, and fool-proof systems are still a few years away. Also at Michigan State, Dr. Kun-Mu Chen is experimenting with a microwave detector that sees through walls, though it cannot penetrate steel.



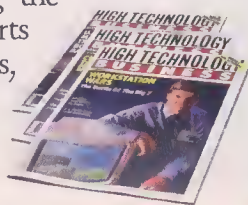
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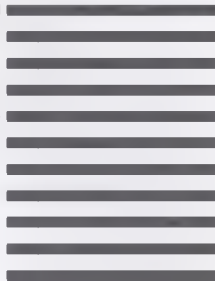
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Apple's Corporate Image

MACINTOSH'S NEW POPULARITY CHANGES COMPUTING

■ By Andrew M. Seybold

APPL E COMPUTER is rapidly becoming a presence to be reckoned with in the fight for the corporate desktop. In the last year alone, the company's share of the personal-computer market has grown from 9 percent to 15 percent.

The factors driving this increase in market share are the desktop-publishing revolution, the demand for business presentations created on a personal computer, and, most recently, the availability of top-notch business and communications software for the company's Macintosh products.

Hughes Aircraft typifies companies that have opted to buy large quantities of Macintoshes, first for the graphics department, then for engineering, and finally for the desktops of the general work force. At last count, Hughes owned more than 10,000 IBM PCs and more than 2,000 Macintoshes. The company says it does not regret its move toward Apple. According to management, the training department has had to run repeated classes for people who use IBM PCs, but most employees need only one session to become productive on a Macintosh.

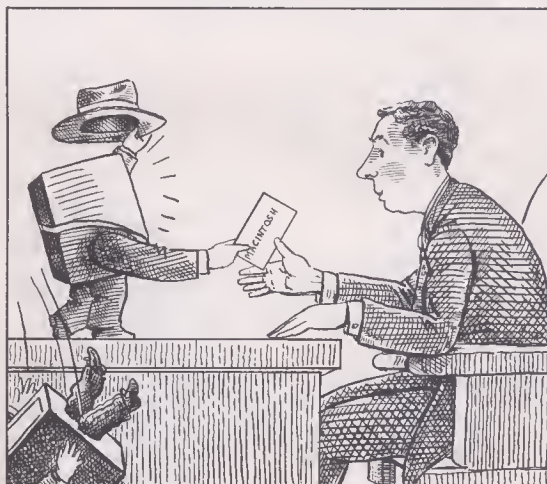
Further enhancing Apple's position in the corporate world is its recent alliance with Digital Equipment Corporation—an alliance forged at least in part because Apple had the foresight to seek out a company with strong ties to the management-information-services community and then provide communications paths between that company's equipment and its own.

Apple's success with the Macintosh can be attributed to that foresight, plus several other factors, among them a powerful central processing unit, a simpler user interface, and persistence.

The Macintosh is based on the Motor-

ola 68000 (a 68020 in the Macintosh II), a high-end processor with more power than the Intel 80286/386 chips used in IBM's desktop computers.

Because the Macintosh's operating system is proprietary, and because Apple designed the interface, all software written to run on Macintoshes must conform to the same standards and use the same type of pull-down menus.



Software vendors are still free to innovate, but the Macintosh standards ensure that all programs work in essentially the same way.

Apple's persistence—its decisions to stay with the concept of the Macintosh and build on it, to listen to what users say they want and need, and to provide more power and more speed within the same framework—has paid off. So has the company's decision to provide (and encourage others to provide) software and hardware that permits easy transfer of files from the IBM desktop world to the Macintosh world and back again (as well as to and from minicomputers and mainframes).

In the short term, this means that Macintosh users can take advantage of a larger selection of software than ever before available. In addition, connecting to other computing environments is

becoming easier, and users are assured that they will be able to upgrade their systems as new and faster machines enter the marketplace.

Apple faces sizable challenges. It must continue its efforts to penetrate corporations, and it must stay abreast of the technology that is driving the entire computer industry. The company's recent agreement with Digital Equipment Corporation and its work with local-area networks and connectivity convincingly demonstrate Apple's understanding that desktop computers are no longer isolated boxes sitting on desks, but an important part of a total computerized office environment.

It will be 18 months or so before the work being done on the IBM side of the industry will be able to compete with the Macintosh operating environment. For Apple, this represents a window of opportunity. Its most important task right now is to convince corporations that it will use this time well and be able to provide what's been promised, but not yet delivered, by the other side of the house.

The new level of acceptability being enjoyed by the "computer for the rest of us" company is certain to have profound consequences. Apple's rise will ensure that its vision—and pronounced desktop mentality—will permeate corporate America's thinking to an increasing extent. The number of people willing to spend large amounts of time and energy learning how to make machines do their bidding is diminishing. Apple is the leader of the next wave, the provider of what desktop workstations are becoming, and a player that no one concerned with the desktop-computer marketplace can afford to ignore. ■

Andrew M. Seybold is editor-in-chief of Andrew Seybold's Outlook on Professional Computing, a California-based newsletter.

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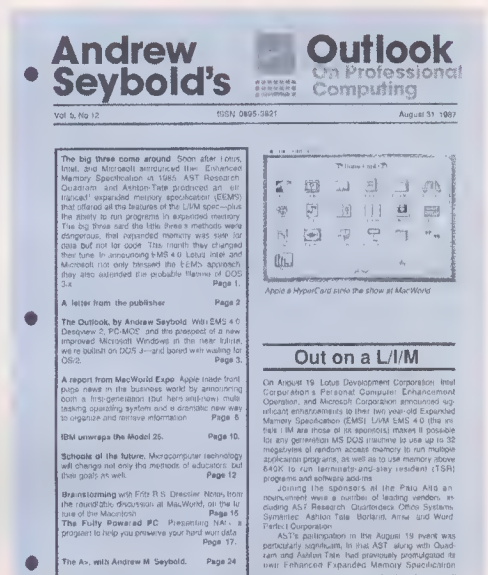
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A New Look in Mainframes

CUSTOMERS PUT EMPHASIS ON SPECIFIC USES

■ By Sarah Glazer

TRADITIONALLY, the mainframe-dominated computer market in Japan has been ruled by large-scale IBM machines and look-alikes from local giants Hitachi, Fujitsu, and NEC. But that situation is starting to change. Customers are no longer content to buy general-purpose computers and rely on their own in-house programmers to develop software. Instead, many Japanese companies now want systems designed for specific uses.

In response, domestic and U.S. computer companies are beginning to carve up the Japanese market, depending on which purpose their machines are intended to serve. Meanwhile, the emphasis on application-specific machines has revamped the software market, creating opportunities for outside software companies.

The new application-oriented machines come mainly from domestic suppliers, as well as a few U.S. companies, says Yoshiro Yoshioka, deputy general manager of Fujitsu's computer mainframe division.

In the growing market for supercomputers used for intensive number-crunching, Fujitsu, Hitachi, and NEC lead the way, reports Yoshioka. "The whole country had just nine supercomputers installed in 1984," he recalls. "Today there are more than 60." But U.S. companies such as Tandem Computers are doing well selling fault-tolerant computers for on-line transaction processing, adds Yoshioka. In addition, U.S. companies such as Digital Equipment Corp. are selling increasing numbers of super-minicomputers for various engineering tasks.

As well as concentrating on different parts of the market, Japanese companies are trying to satisfy customer needs for the software that lets the

computers do their jobs. To help meet the growing demand for application software in almost every area, Japan's domestic computer suppliers are beginning to form regional software-development centers. Fujitsu has established 39 such centers, NEC has 16, and Hitachi has 14, according to Yoshioka.

To some extent, Japanese hardware makers are trying to fill a longstanding

gap in the country's computer industry. Unlike the United States, Japan has never had many independent software companies, says David Moschella, vice president of computer systems research for International Data Corp. in Framingham, Mass. "Japan does not have nearly as large an independent software industry as the U.S. [does]," he says, "partly because the Japanese are less entrepreneurial."

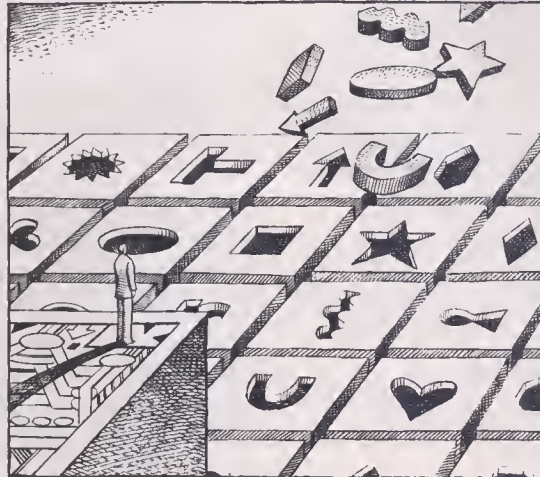
Foreign software companies are also attracted by this void in the market, says Bill Totten, president of Tokyo-based K.K. Ashisuto, Japan's largest distributor of mainframe-software packages. He says a growing proportion of mainframe software sold in Japan comes from U.S. companies such as Atlanta's Management Science America Inc., which makes accounting and other applications software, and Oracle Corp. of Belmont, Calif., which makes database-management programs. Although software from U.S. companies must be translated into Japanese characters, many programs are otherwise fairly simple to adapt. "Accounting rules are very similar in Japan and the U.S., so those applications translate easily," says Totten, as do such engineering packages as computer-aided design programs.

Perhaps the biggest revolution in the Japanese market for mainframe software has been the entrance of industrial companies selling programs they originally created for their own use. "The information-processing industry in Japan today is very hot—companies in practically every manufacturing sector are trying to enter it," says Fujitsu's Yoshioka. Of 92 food and textile corporations on the Tokyo stock exchange, he reports that the exchange lists 33 as entering the information-processing industry. Of those 33 companies, 13 have introduced software

products. Similarly, nine of the 15 oil and rubber producers listed have entered the information-processing field, and five are selling software.

The increasing diversity of the Japanese computer market creates new problems even as it solves old ones. "Many companies would like to distribute their information systems across computers of varied sizes because it's more economical," says Totten, but he notes that application programs rarely work with several types of computers. Thus, he predicts, "programs that run on an array of computers from mainframes to micros will find a growing market in Japan," helping to create even greater diversity in the future. ■

Sarah Glazer is a free-lance business writer who writes frequently about the computer industry.



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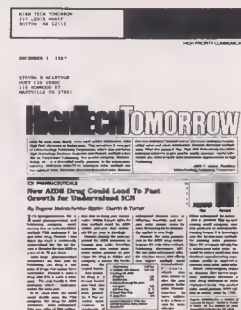
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Let the Buyer Beware

TECHNOLOGY RIGHTS ARE KEY TO TAKEOVERS

■ By David Hammer

GENERAL MOTORS AND Electronic Data Systems. IBM and Rolm. Computer Associates and UCCEL. These success stories are only a few of the recent mergers and acquisitions that have involved well-known high-technology companies.

Unfortunately, there's another side to the story. Once an acquiring company takes control of its purchase, it may find that it doesn't own the technology that made the company a desirable takeover target in the first place. When a company with deep pockets buys a smaller outfit, lawsuits over technology ownership seem to crawl out of the woodwork.

Purchasers may discover they do not get the technology they think they're buying and can be liable for huge judgments. Even if a suit fails, an acquiring company's legal costs to defend itself can add to the total price of the acquisition.

The issue can arise at any point in the process. Last year, the day after Bristol-Myers signed an agreement to buy Scimed Life Systems, competitor Eli Lilly filed a suit claiming that Scimed's product—a coronary angioplasty catheter used to treat heart disease—infringed on Eli Lilly's patents.

Disputes over technology ownership can kill a deal before it's final, but the threat doesn't stop there. When chip-maker Mostek fell on hard times, United Technologies bought it and later sold it to France's Thomson CSF. Motorola Corp. then sued, claiming that Mostek had infringed on its patents for the 68000 computer chip. Motorola asked the court to force United Technologies to take back Mostek and pay Motorola \$30 million as compensation.

To avoid such problems, buyers must make sure they acquire good title to the company's technology or obtain the

marketing rights under acceptable terms. Buyers (or their legal teams) should interview the people who developed the technology to determine if it was developed while they were employed by the target company. Employment agreements should be checked to ensure that these individuals agreed the technology would be the property of their employer. If not, or if the develop-

software and demand that the company stop distributing it to others.

When considering companies that hold marketing rights to a technology but do not own it, buyers must check with the technology's owners to ensure that the company can transfer the marketing rights and that the owners agree to the transfer. This can be easy, expensive, or impossible; many technology owners are unwilling to transfer rights to competitors at any price.

Even if the owner agrees to transfer marketing rights, that agreement could still restrict the buyer's use of the technology. For example, marketing agreements are often limited to a certain time period or region, drastically reducing the technology's value to the purchaser. Several years ago a major software company had to abandon a \$1-million deal to acquire an accounting-software company; at the last minute the buyer discovered that the company didn't own the package but merely had the rights to market it, and those rights would expire in a year.

Sometimes, however, a deal is so attractive that a company will go ahead despite obvious legal problems. For example, Australia's Teletronics Holdings bought the pacemaker unit of Miami-based Cordis last year in a bid to become the world's second largest pacemaker manufacturer. This goal was so important that Teletronics agreed to assume liability for an outstanding patent-infringement suit filed by Medtronic.

The best way to avoid acquisition problems is to ask the right questions about the technology and be sure the answers are backed up in writing. ■



ers reserved ownership rights, buyers must determine whether the developers later transferred ownership of the technology to the company.

After determining that the company established ownership, the buyer must still make sure that the company protected its rights—preferably by patenting hardware and copyrighting written processes, know-how, and software. If such precautions were not taken, customers may be free to clone and resell the technology, which could undercut the products and severely reduce the company's market value.

Buyers must also be alert for agreements in which companies sell their technology rather than license it. Several end users have sued software companies that sold them programs instead of a license to use the programs. These customers claim that they thus own the

David Hammer, a Dallas-based attorney with Reynolds Shannon Miller Blinn White & Cook, specializes in acquisitions of high-technology companies.

Cash Crisis Creates Biotech Alliances

As traditional funding sources dry up, many companies are trading independence for financing

BY FRANCESCA LUNZER

Poor Little Endotronics. The seven-year-old company tried to make it in biotechnology by developing health-care products, such as a genetically engineered vaccine to prevent hepatitis B. But in March 1987, the Minneapolis-based company filed for protection under Chapter 11 of the federal bankruptcy code, and now hopes to return to its earlier business of making cell-culture instruments, which was less glamorous but more secure. When asked to pinpoint the cause of this downfall, head of corporate planning Susan Smith says, "It was the products that killed us."

Products are killing many biotechnology companies. There are about 300 such companies, both public and private, founded in the last decade to make products based on recombinant DNA or monoclonal antibodies. All had hoped to ride the promise of these new technologies to success.

The technologies work—recombinant DNA combines genetic material to create new drugs or produce greater quantities of existing ones; monoclonal antibodies deliver agents to a specific site in the body, making them more effective. But the vision of an independent biotech industry is fading fast as new business realities send once-hopeful companies scrambling for the cash

they need to stay alive. In most cases, such companies are forming strategic alliances with established pharmaceutical companies, bartering some share of their product rights for financial backing. No doubt some biotech companies will fail altogether.

This trend is changing the face of what many participants expected the biotech industry to look like. Instead of operating as independent companies introducing products of their own and reaping huge profits in the early 1990s, many surviving biotech players will probably wind up under the wing of powerful patrons.

The problem is that the traditional pillar of middle- to later-stage biotech funding—the stock market—has all but run dry. That's bad news for the more than 200 small biotech companies faced

with the expensive task of turning their ideas into medical products. On average, it costs about \$100 million to fund a biotech product from early research through marketing, with at least two thirds of that spent on human trials and market introduction. "It only costs about \$10,000 to develop a new monoclonal antibody in the lab," says Katie Siafaca, director of information products at Biomedical Business International, "but the testing and marketing costs tens of millions."

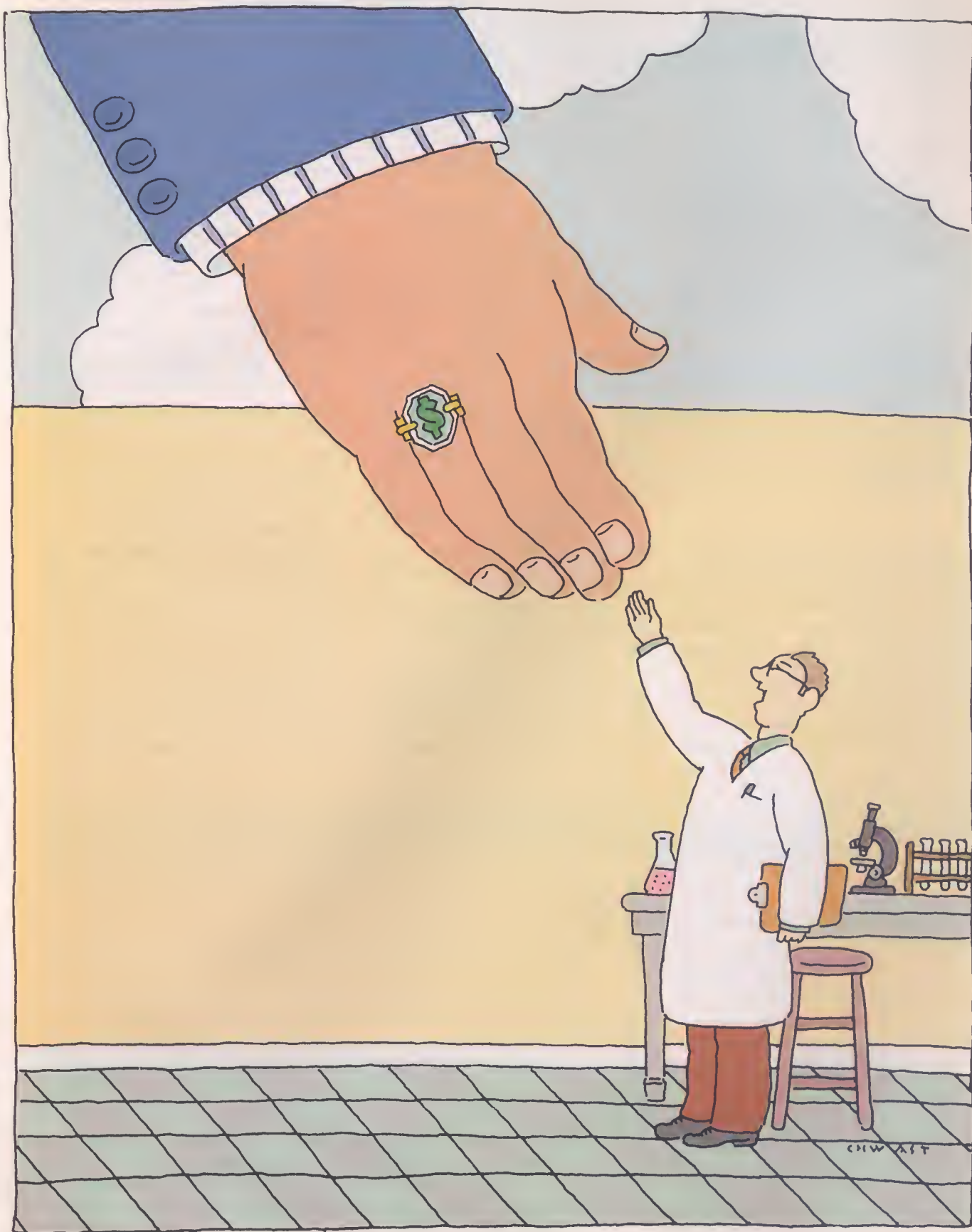
As recently as the first half of 1987, raising money beyond the startup phase was not a problem for biotechnology companies. They were the darlings of the investment community, especially in the stock market, where at least \$1.5 billion has been invested in biotechnology since 1976.

However, last October's Wall Street crash effectively closed the public equity markets for initial and even secondary stock offerings. It's a big loss. Most biotech companies formed in the last 10 years started with either venture-capital or private funding, but counted on an enthusiastic reception in the stock market when they took their tiny companies public, even if they were years away from product introductions and earnings. High hopes and investor euphoria inflated many biotech stocks.



James Grant of T Cell Sciences (left) and Pfizer's Barry Bloom: partners.

WALTER BIBIKOW



SEYMOUR CHWAST

5 ON THE ROPES

COMPANIES THAT CANCELLED PUBLIC STOCK OFFERINGS
AFTER THE CRASH OF OCTOBER 19, 1987

| COMPANY | MAJOR PRODUCT | STRATEGIC ALLIANCES | POSSIBLE ALTERNATE FINANCING |
|--|--|---|--|
| Applied Immune Sciences 200 Constitution Dr. Menlo Park, CA 94025 (415) 326-7302 | Treatments for immune-system diseases such as hepatitis and AIDS | Marketing agreements with Baxter Travenol; no research funding | Seeking \$10 million through a private placement |
| Creative Biomolecules 35 South St. Hopkinton, MA 01748 (617) 435-9001 | Growth factors and biosynthetic antibodies | Pursuing minor products with Stryker and Biospecific Technologies | Recently acquired a limited R&D partnership to fund clinical trials for growth factors |
| Gene Labs 505 Penobscott Dr. Redwood City, CA 94063 (415) 369-0500 | Tests and treatments for diseases such as AIDS | Sandoz, Abbott | Ongoing discussions with potential licensing partners |
| Immunomedics 5 Bruce St. Newark, NJ 07103 (201) 456-4779 | Antibodies for cancer tests and treatments | Johnson & Johnson, Centocor | Pursuing additional strategic alliances and R&D partnerships |
| ZymoGenetics 4225 Roosevelt Way N.E. Seattle, WA 98105 (206) 547-8080 | Growth factors for wound healing | Novo Industri, Hoffman LaRoche | Discussing joint development programs with larger companies |

SOURCE: HIGH TECHNOLOGY BUSINESS RESEARCH

"Biotech stocks exaggerate market conditions," says David Webber, editor of the newsletter *Biotech Investor*. "They rise higher when the market is high and fall lower when the market is low. Because investors don't have earnings to base their investment decisions on, they base them on news stories and rumors instead."

The value of biotech stocks plummeted 44 percent last October 19—twice the percentage drop of the market as a whole, according to Linda Miller, a securities analyst at Paine Webber. As of February, these stocks had recovered only 23 percent of their value. A pre-crash survey by Arthur Young shows that companies with 50 or fewer employees were counting on stock offerings for 47 percent of their 1988 funding. Now these companies must find other sources at a time when the quality of the science and potential products are under far more scrutiny. "There are biotech companies that went public in good times that shouldn't have," says Robert Goldstein, president of Equity Group, a financial-relations firm.

For example, Vestar of Pasadena, Calif., and Liposome Company of Princeton, N.J., were still trading below their initial stock prices in early February. The two companies are developing liposomes, microscopic fatty bubbles that deliver drugs to the body precisely

and efficiently. Sarah Gordon, who follows biotechnology for Hambrecht & Quist, attributes the drop to the fact that liposome technology isn't well understood by investors, and also to the lack of clinical trial data.

Only some of the companies caught in a cash crunch might look to late-stage venture-capital funding. Wayne Fritzsche, a partner with the health-care consulting firm Fritzsche, Pambianchi & Associates, says there is a "flight to quality" among venture capitalists, making it hard for companies to get funding if competitors are closer to market with the same products.

Research and development partnerships were once an important part of early biotech funding, with cash-rich limited partners investing in products under development. When products started making money, the partners were to be paid royalties, though some companies (including California Biotechnology of Mountain View, Calif., and Genentech) have bought back some of their limited partnerships in exchange for company stock.

Today, however, changes in the tax laws have made such partnerships less attractive to independent investors. Limited partners now count on getting stock-share appreciation rather than

royalties, so prospective limited partners are far more interested in companies that have products already in clinical trials, increasing the chance that the stock will rise in value. Therefore, says Fritzsche, limited partnerships are potential revenue sources only for larger biotech companies that can give greater assurances of success. For example, Nova Pharmaceuticals of Baltimore, Md., which went public in 1983, set up a \$42-million limited partnership at the end of 1987 despite a \$7-million operating loss during the first nine months of the year. The proceeds of the partnership will fund development of a product to administer chemotherapy and to continue work on a new pain reliever.

So what are the prospects for the industry? Roger Shamel, president of Consulting Resources, once predicted a consolidation from 300 to about 150 biotech companies via mergers and acquisitions over the next 10 years. But that was before October 19. "I've revised my view since the crash," he says. "Now I think we'll see some firms fail."

It's too early to predict which ones. At least five biotech companies have chosen not to complete public offerings (see "Five on the Ropes," above), and thus need other sources of funding. But prospects are worst for smaller companies that don't have a product already being developed in the lab.

This situation is particularly frustrating for fledgling biotech companies in light of the vast potential of their industry. Last year, industry sales totaled \$1 billion, most of it going to three companies—Genentech, Eli Lilly, and Merck. (Lilly and Merck are major pharmaceutical houses that have licensed products from smaller biotech companies.) Sales will reach \$50 billion to \$100 billion by the year 2000, predicts Steven Burrill, chairman of Arthur Young's high-technology group. Several new products slated for introduction as early as 1991 are expected to create markets worth hundreds of millions of dollars. These products include erythropoietin, a protein that regulates the creation of red blood cells; epidermal growth factor, which speeds the healing of wounds; and a clotting factor, which will control bleeding for an estimated 20,000 people with hemophilia.

Many young biotech companies must watch helplessly as these emerging markets are pioneered by competitors who got an earlier jump on development, usually with the help of old-guard

pharmaceutical houses. For instance, erythropoietin, which will have a worldwide market worth as much as a billion dollars, is being worked on by at least six companies, with several others in early stages of development. However, the first product on the market will be one developed by Amgen, funded in part by Kirin Brewery of Japan and Johnson & Johnson. Although Kirin owns Japanese marketing rights and Johnson & Johnson has almost all U.S. rights, Amgen has retained U.S. rights to the kidney-dialysis market, which could bring in \$200 million to \$300 million dollars.

Meanwhile, many of the independent companies are still in research, years away from even applying for Food & Drug Administration approval.

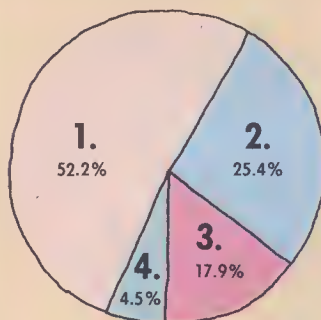
Similarly, in addition to several tiny companies doing research in clotting factors, Genentech, Biogen of Cambridge, Mass., and Chiron are developing versions that are two to five years away from introduction. But a clotting factor from the marketing alliance between Genetics Institute of Cambridge, Mass., and Baxter Healthcare of Deerfield, Ill., will probably be out by 1991.

Not all the products from independent biotech companies are being taken over. Genentech is already considered one of the legendary successes of high technology. In just the last six weeks of 1987, its tissue plasminogen activator (TPA), a drug that dissolves blood clots in coronary arteries, reaped sales of more than \$60 million. At least four other biotech companies are close to significant product introductions and have

WHO OWNS BIOTECHNOLOGY?

1987 SALES OF THERAPEUTIC PRODUCTS

Total Market: \$670 million



1. ELI LILLY
human insulin
\$350 million

2. GENENTECH
human growth hormone, TPA
\$170 million

3. MERCK
hepatitis-B vaccine
\$120 million

4. JOHNSON & JOHNSON
akt 3 (prevents kidney rejection)
\$30 million

SOURCE: HIGH TECHNOLOGY BUSINESS RESEARCH

enough cash to see them through (see "The Five Leaders," next page).

But the vast majority are not as well prepared. They need cash, and those companies that aren't bringing in tens of millions of dollars have basically two ways to get it. They can do contract research and development for larger companies, a vassalage based on services, not products. Or, they can sign market-

ing agreements with mainstream pharmaceutical companies, giving away at least partial rights to products that until recently biotech companies had coveted as their passports to prosperity.

"Companies that dreamed of becoming full-fledged pharmaceutical houses, as Genentech has this year by introducing TPA, are beginning to realize that in order to stay alive they may have to do longer-term research for the big guys instead," says Arthur Young's Burrill.

One might argue that there are worse fates than becoming a for-hire research laboratory, but it's an unsavory alternative for biotech companies that once seemed headed for riches and independence. Contract work may build up a war chest for future product development, but it gives competitors a chance to get ahead in developing products that the company under contract hoped to work on. This serves to push a company away from its goal of becoming an independent biotech house.

Companies that don't want to risk the contract-research route can pursue so-called strategic alliances with larger pharmaceutical and chemical outfits. Well-structured strategic links often give a biotech company research-and-development funds, manufacturing revenues, and royalties on product sales. For example, Genentech is marketing TPA independently, but Eli Lilly has U.S. marketing rights to Genentech's first product, human insulin, and pays a royalty of about 10 percent. Often, large companies will take an equity

STARTUPS STILL ATTRACT MONEY

Although late-stage and public funding looks grim for many biotech companies, startups can still get venture-capital funding, especially if they offer a revolutionary technology. "We have funded four new startups recently," says Brook Byers, a partner with the venture firm Kleiner, Perkins, Caufield and Byers, "and a lot of our friends are doing the same."

According to Wayne Fritzsche, a partner with healthcare consultants Fritzsche, Pambianchi & Associates, venture capital has as much as \$1 billion reserved for medical technology and biotechnology.

Byers notes that the current stock market has little impact on startup companies seeking first-stage funding. "A startup now wouldn't go public for four or five years, so it's irrelevant to think about what the public markets would be like then," he says.

Fritzsche and Byers agree that startups working on a technology that established companies are already developing would probably have a hard time finding backers. However, a number of emerging technologies are good candidates for funding, including site-specific drug-delivery systems and transgenic animals, which produce large quantities of genetically engineered proteins.

For example, Commonwealth Bioventures—a "superincubator" in Worcester, Mass., that lines up venture funds while providing management assistance and lab facilities—started Transgenic Sciences last January to develop hens that lay eggs with less cholesterol. Another recent example is the startup Progenex, backed with \$1.6 million from Kleiner, Perkins and two other venture firms. The company, based in La Jolla, Calif., is doing oncogene research for cancer tests and treatments.

THE 5 LEADERS

CASH-RICH COMPANIES WITH MARKET-READY PRODUCTS

| COMPANY | PRODUCT | PURPOSE | PROJECTED U.S. MARKET | PLANNED INTRODUCTION |
|---|-------------------------|--|-----------------------|----------------------|
| Amgen 1900 Oak Terrace Lane Thousand Oaks, CA 91320 (805) 499-5725 | Erythropoietin | Regulates red-blood-cell production, preventing anemia in kidney-dialysis patients | \$200-\$300 million | 1988 |
| Centocor 244 Great Valley Pkwy. Malvern, PA 19355 (215) 296-4488 | Myoscint | Provides better cardiac imaging after heart attacks | \$60 million | 1989 |
| Cetus 1400 53rd St. Emeryville, CA 94662 (415) 420-3300 | Interleukin-2 | Cancer treatment | \$285 million | 1990 |
| Chiron 4560 Horton St. Emeryville, CA 94608 (415) 655-8729 | Epidermal growth factor | Promotes wound healing; Chiron holds the rights for eye treatments | \$100 million | 1989 |
| Genentech 460 Point San Bruno Blvd. South San Francisco, CA 94080 (415) 266-1000 | Human growth hormone | Promotes growth in children who lack growth hormone | \$100 million | 1985 |

SOURCE: HIGH TECHNOLOGY BUSINESS RESEARCH

stake in their biotech partners—Johnson & Johnson owns 9 percent of Immunomedics, Baxter Travenol has 7.5 percent of the stock of Genetics Institute, and New York's American Home Products owns 13.5 percent of California Biotechnology. Partial ownership gives a large company a way to exert influence and protect its investments. The small company gets cash.

Although some large companies take an equity stake with an eye toward later acquisition, most analysts predict few biotech takeovers, even though low stock prices currently make acquisitions look attractive. For one thing, many biotech companies are already so entangled in alliances with competitors in the chemical and pharmaceutical industries that an acquiring company wouldn't be able to market all products under development. Also, the productivity of most biotech concerns is related to their freewheeling and innovative laboratory atmosphere, says Denise Gilbert, an analyst with Montgomery Securities. The managers and scientists of such companies often resist the inevitable bureaucracies of large houses—many of the original key personnel at Hybritech, a company acquired by Eli Lilly in 1985, and at Genetic Systems, bought by Bristol Myers the same year, have since abandoned the ventures.

"That's the beauty of strategic linkages," Gilbert says. "You can get rights to profitable products without having to buy the whole company."

Despite the advantages, many small independents rejected alliances; the promise of vast biotech markets tempted them to go it alone. According to the Arthur Young survey, before the stock-market crash small biotech companies expected to get only 13 percent of their 1988 funding from strategic links with larger companies. Now these companies must rethink their positions, and the deals they sign may reflect their desperation. "With the equity markets closed for the time being," says Gordon of Hambrecht & Quist, "companies might be forced to give away more than they'd like to."

"We know that if we're going to be a fully integrated product company, we're going to need to take products we develop directly to the marketplace," says Donald Hawthorne, director of finance for Gene Labs. To fund clinical trials and manufacturing, the company had planned to go public in late 1987 or early 1988. Now it's seeking alternative sources of financing.

Companies with less than two years of cash on hand are most in need of strategic alliances. If they're shrewd—and lucky—such players will pen agreements similar to ones cut by biotech front-runners Amgen, Cetus, and Gen-

entech. These companies and others traded some marketing rights for research-and-development funds, but retained rights in specific market segments. This allowed them to earn more revenues and gain valuable experience in marketing.

Such arrangements also seem to be working for some of the industry's relative upstarts. An example is T Cell Sciences of Cambridge, Mass., which is developing diagnostic and therapeutic products based on T cells, the type of white cells that help regulate the immune system. The small company has licensing contracts with Pfizer, Syntex, and Yamanouchi for some of its T-cell products, but has retained rights to diagnostic kits that detect receptors shed by the T cells into the bloodstream. For example, it is seeking FDA approval for a kit to diagnose a rare form of leukemia. The test will find a much smaller market than the products T Cell Sciences has licensed away, but it's a start.

To market its product, T Cell Sciences will use \$12 million from a 1986 public offering. The company plans to parlay its earnings into other developments to maintain an independent arsenal of proprietary biotechnology products. "In all cases, we're seeking product-development partners, not technology-development partners," says chairman James Grant, a former FDA deputy commissioner. "Once we give away technology, we're giving away part of our proprietary base."

Pharmaceutical giant Pfizer has a three-year agreement with T Cell Sciences worth several million dollars. The agreement gives Pfizer exclusive worldwide rights to any autoimmune-disease treatments that result from research on T-cell antigen receptors. Barry Bloom, president of the Central Research division at Pfizer, says T Cell Sciences' research might result in treatments for rheumatoid arthritis, diabetes, and other autoimmune diseases in which the body attacks itself.

This agreement leaves T Cell Sciences with the rights to diagnostic products and therapies for other diseases, plus \$4.5 million to \$7 million over three years with options to renew.

With a T Cell Sciences treatment for rheumatoid arthritis, Pfizer could have a replacement for its Feldene, the third best-selling anti-inflammatory drug. Feldene brought in \$245 million in 1986, but its patent expires in 1992. Products licensed from T Cell Sciences might also

augment Pfizer's research on treatments to prevent the degenerative effects of diabetes.

"This arrangement is beneficial to both parties," says Bloom. "Patrick Kung [T Cell's scientific director] and his co-researchers are world-class leaders, and by collaborating with them we were able to enter the biotechnology field more efficiently and rapidly. The arrangement lets T Cell Sciences do research on this technology better than they could have alone, and they will reap benefits beyond Pfizer's rights."

Many companies, however, are forced to accept less advantageous conditions. For example, in May 1987 Repligen Corp. of Cambridge, Mass., signed an agreement giving Merck worldwide rights to an AIDS vaccine now under development, leaving Repligen with only research funds and the promise of future royalties on sales. The market for AIDS vaccines promises to be enormous, with intense competition; two other companies have FDA approval to begin clinical trials and still others are developing vaccines. Still, if Repligen's vaccine turns out to be effective it could pull in hundreds of millions of dollars, of which Repligen will see only a fraction. "Repligen can't afford to think of the untold millions it might be giving up," says Shamel of Consulting Resources. "It needs the contract money now."

Companies that give up proprietary technology and worldwide marketing rights may end up as little more than supply houses for the pharmaceutical giants. "In the end," says Paine Webber's Miller, "those that survive will be the ones who were able to make the most advantageous agreements." To do so, she says, companies need enticing products to barter for better terms.

One company that managed to pull that off is Genetics Institute. Its blood-clotting factor has a projected market of about \$250 million, enough to entice Baxter to fund development and take a 7.5 percent equity stake in the company. This infusion of money is buying time for Genetics Institute to develop its own products, including a second-generation version of TPA.

Other products cannot command such favorable terms. Applied Immune Sciences, which postponed an initial public offering originally set for last October, has only \$6 million on hand



Eugene Schuster's Quest Biotechnology is finding markets for troubled biotech companies.

from an initial \$18 million in venture capital. The company is working on products to treat disorders of the immune system, products Baxter Travenol has agreed to market—if Applied Immune Sciences gets them through development. The smaller company must come up with development funds on its own.

Other hazards lurk in alliances. Integrated Genetics of Framingham, Mass., was left in the lurch when the German chemical and pharmaceutical giant BASF terminated an agreement. Stuart Weisbrod, a biotech analyst with Prudential Bache, says BASF had planned to jointly market a second-generation TPA product developed by Integrated Genetics, but just before clinical trials it decided Genentech was already too far ahead. Although Integrated Genetics plans to do clinical trials on the product on its own, it has only about \$30 million in cash. This is not enough, and the company will have to find ways to raise more money to fund the product.

Guiding executives at biotech companies might like to consider this funding drought as a temporary situation that will correct itself. But Eugene Schuster, chairman of Venture Funding Ltd. in Detroit (which is financing Endotron-

ics' emergence from bankruptcy) thinks the industry should wake up and smell the lab chemicals. "Since the second world war, pharmaceutical houses have had profit margins of 15 percent, so everyone thought they could look forward to the same thing," he says.

Instead, small companies may have to change the definition of success to include gross revenues of only \$25 million to \$50 million a year from licensing deals, says Schuster. He's following his own advice. His company specializes in helping startups and floundering companies, and he sees strategic marketing as an excellent source of revenue. The firm has formed Quest Biotechnology in Detroit, a company that acquires undervalued technologies in exchange for Quest stock, then licenses the technologies to corporate partners for commercialization. For example, Polycell, a subsidiary of Quest, has licensed its monoclonal antibody to Centocor for use in cardiovascular, gastrointestinal, and ovarian imaging.

"I don't have any expectations for making Quest's subsidiaries fully integrated health-care companies," says Schuster. At least for the short term, biotech companies should share and act on Schuster's expectations. ■

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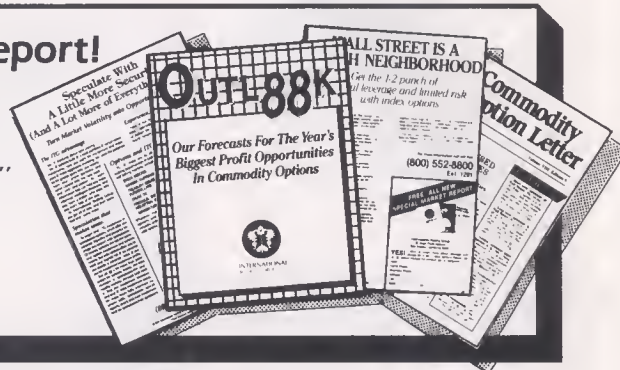
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TV The Push for A Sharper Picture

*As the international fight over standards intensifies,
some companies are making money now*

BY HERB BRODY

WATCHING television is like looking through a smudged window—after a while, you get used to not being able to see clearly. The biggest advance in television technology since the advent of color will be like a rag soaked in Windex, as major television and electronics companies around the world compete to introduce the era of “high-definition” television.

High-definition TV (HDTV) is designed to make television pictures as sharp and detailed as movie images. Today’s TV sets coarsely slice images into 525 horizontal strips, or scan lines. High-definition technology generates as many as 1,125 lines, filling in the missing details for a picture as good as that produced by 35-millimeter film.

The new format also expands today’s squarish screen into a rectangle that has a width-to-height ratio of five to three, instead of the four-to-three aspect ratio of conventional sets. This wider screen matches the dimensions of movie-theater screens; regular screens cut off the sides of movies made for theaters. All told, high-definition pictures contain about five times as much visual information as ordinary television images.

Therein lies the rub. The ability to create high-definition TV pictures has



Sony's William Connolly hopes high-definition TV will win him profits as well as awards.

been available for several years and is already causing profound changes in the film and video production industry. The long-term problem is how to transmit these information-rich signals over broadcast channels designed for much less detailed pictures. At the same time, HDTV’s hunger for additional airspace has triggered a bitter war between TV broadcasters and mobile-radio companies over control of the radio spectrum.

So far, the most advanced HDTV technology comes from NHK, Japan’s government-owned national broadcasting company. Although the NHK system offers high technical quality, it is totally incompatible with existing television sets. Nevertheless, the Japanese aim to establish it as the new worldwide television standard, as they have with their standards for videocassette recorders and compact-disc players.

But TV makers and broadcasters in Europe and the United States are not knuckling under. As the Japanese gear up to move HDTV out of the lab and into the marketplace, competing approaches have popped up like sitcoms in September.

Companies such as Philips and GE are pushing their own HDTV systems to head off adoption of the Japanese plan. Smaller outfits such as the Del Rey Group and the New York Institute of Technology have also developed HDTV systems and are looking for champions to help them battle the world’s electronics giants.

While the world slugs it out to establish the best way to deliver sharper TV pictures to the home, high-definition TV is well on its way to becoming the medium of choice for *producing* programs. Movie makers, TV networks, and independent producers are discovering that HDTV can give them video’s flexibility

E.J. CAMP

yet still match the high picture quality of 35-millimeter film.

Sony, the early leader in HDTV production equipment, has offered a complete line of high-definition equipment since 1983, including cameras, recorders, and monitors. Ikegami makes a camera as well as a switcher that converts high-definition footage into conventional video and vice versa. Hitachi makes the image pickup tube that both Sony and Ikegami use in their cameras. Many other Japanese companies, including Matsushita (alias Panasonic), Toshiba, NEC, Sanyo, and Mitsubishi, will probably put equipment on the market in the next 12 to 18 months, according to most observers. The lone U.S. company still making professional video equipment—Ampex—has not announced involvement in high-definition technology.

About 80 studios now use high-definition video to produce everything from 30-second commercials to feature-length presentations, according to Andrew Lippman of the Media Laboratory at the Massachusetts Institute of Technology in Cambridge, Mass. The push is chiefly economic. "The cost of 35-millimeter film production has been rising at a rate of 15 percent a year," says Rupert L. Stow, director of production systems analysis at CBS. "It's becoming a real constraint." High-definition video, he says, can be produced for about half the cost of film.

In the past, that advantage was outweighed by film's vastly superior image quality. But high-definition TV removes that edge. Now producers have a medium that offers all the convenience of video—for example, they can easily achieve special effects such as superimposing an actor's image onto a background—yet matches or exceeds the picture quality of film.

A small group of New York production studios were the first to move beyond experiments and use high-definition TV for commercial production. Barry Rebo at Rebo High-Definition Studio Inc., one of Sony's first high-definition TV customers, has used the equipment to produce music videos (a visualization of John Lennon's "Imag-

ine" competed at last year's Cannes Film Festival) as well as nationally aired commercials for clients such as Sony and Reebok. Rebo says HDTV ushers in a new era of images. "We're telling clients that they've looked at their last film production," he says.

The first feature-length movies shot in high-definition video are just starting to appear. An example is the film *Julia and Julia*, starring Kathleen Turner; 97 percent of the footage was shot in high-definition video.

Even though

Largely because of the stiff initial cost, the market for high-definition production equipment is modest. A handful of studios will set up high-definition systems this year, and perhaps a dozen more will do so in 1989, predicts Craig Tanner, Sony's business manager for high-definition video. That amounts to industry-wide sales of considerably less than \$50 million. William Connolly, president of Sony Communications Products, says that HDTV is "a small part of our division in terms of dollar volume. But because it's a market development project, a good deal of our energies are devoted to it."

The slow pace of the high-definition equipment business will not greatly affect any of the present players, whose bread and butter comes from conventional video products. Ikegami has yet to deliver a high-definition system outside Japan, but continues doing a brisk business in studio cameras and monitors, as well as in electronic news-gathering systems.

Although makers of HDTV products so far have focused on selling to studios and production companies, the technology may find more widespread use

in other sectors of the economy. For example, retail chains could use satellites to send high-definition pictures of new merchandise to branch stores, so managers can make buying decisions on the spot. Companies such as K Mart, Sears, and J.C. Penney have set up satellite networks to distribute data, but increasingly these networks are carrying video programming.

HDTV is delivering its first profits in the movie-production industry, but this market pales beside the promise of broadcasting HDTV over the public airwaves and selling new TV sets and VCRs to consumers.

Television sets capable of displaying the big, sharp pictures will probably appear in the United States in 1990, according to Tom Keller, chief scientist for the National Association of Broadcasters. By 1995, consumers will be spending \$20 billion to \$30 billion a year on high-definition equipment, predicts

THE EARLY PLAYERS

PRODUCTION EQUIPMENT:

Hitachi Denshi America

175 Crossways Park West
Woodbury, NY 11797
(516) 921-7200

Products: Cameras,
video pickup tubes

Sony Communications Products

1600 Queen Anne Rd.
Teaneck, NJ 07666
(201) 833-5261

Products: Cameras, monitors, videotape
recorders, projection systems

Ikegami Electronics (USA)

37 Brook Ave.
Teaneck, NJ 07607
(201) 368-9171

Products: Cameras, monitors,
switches

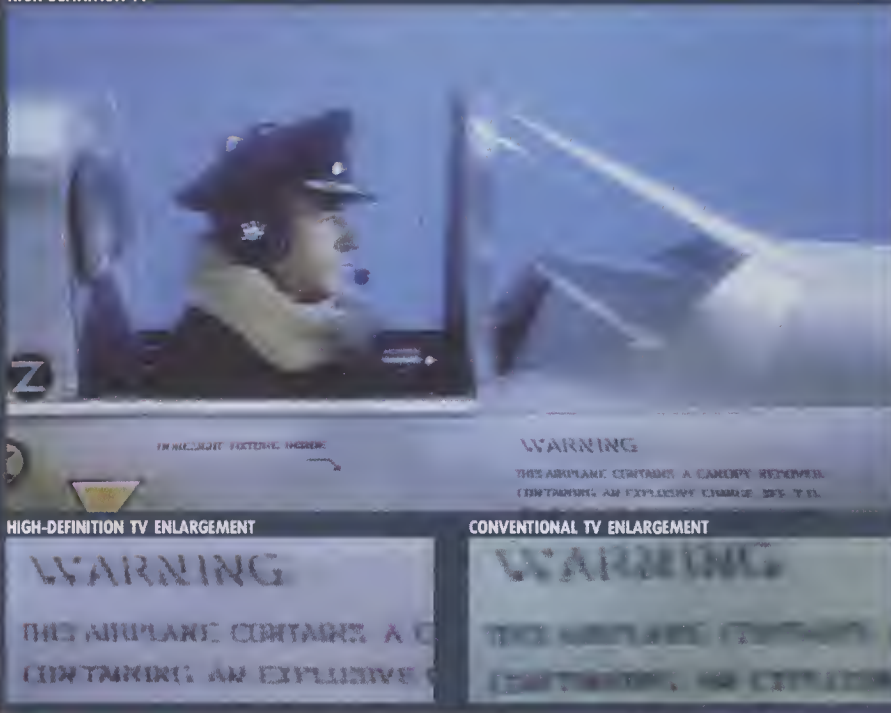
SOURCE: HIGH TECHNOLOGY BUSINESS RESEARCH

the film was budgeted to shoot for 16 weeks, it was done in 12, partly because of shortcuts made possible by video.

In the made-for-TV arena, the Canadian Broadcasting Company (CBC) ran a 14-hour romance miniseries in March called *Chasing Rainbows*, shot entirely in high-definition video by Toronto-based Northern Light and Picture. Previous CBC dramas used 16-millimeter film, but HDTV offered better quality.

Despite these pioneers, high-definition production remains largely a province of avant-garde studios such as Rebo and 1125 Productions. Even though high-definition production costs are equivalent to standard video, HDTV equipment is monstrously expensive. A full studio setup including two cameras, several videotape recorders, and a complement of monitors, switches, and other necessary equipment costs \$2 million to \$5 million—three times the price of conventional video equipment.

HIGH-DEFINITION TV



High-definition TV systems display wider, sharper pictures than those of ordinary TV, with a quality comparable to that of 35-millimeter film. This computer simulation shows an image on ACTV, an interim system developed by the Sarnoff Research Center for GE and NBC. The samples of text show the improvement of ACTV (left) compared to conventional TV (right). ACTV requires a single broadcast channel and works with existing TV sets; further picture improvements would be possible in the future by transmitting additional detail over a second channel.

MARTIN S. ZAK

William Glenn, director of the New York Institute of Technology's Science and Technology Research Center in Dania, Fla.

With that kind of money at stake, it's no wonder that high-definition television has been attracting attention. But apart from the production industry, there won't be much money in it until the industry hurdles a barrier that has challenged most new consumer technologies. The problem: There's little motive for TV stations to broadcast high-definition signals until enough homes own the right sets to watch them on. Unfortunately, few people will buy (or manufacture) HDTV sets until stations start broadcasting high-definition programming.

Cable TV and videotape will probably force the issue for broadcasters. HDTV video cassettes could be available for specially equipped VCRs in two to three years, and HBO and other cable programmers may transmit selected shows in HDTV soon after that. "High-definition TV would be a cheap gamble for somebody like HBO," says Gregory DePriest, vice president of the Association of Maximum Service Telecasters, a Washington-based lobbying group of 270 television stations.

Naturally, the cable industry is ready to embrace any technology that gives it an edge over its broadcast competition.

Cable operators, who transmit their programming via satellite and fiber-optic or coaxial cable, do not have to adhere to broadcast-TV standards. Unlike the airwaves, cables are private property, and cable operators can carve up the carrying capacity any way they please. Expanding channels to accommodate the new detail-rich format "is just a matter of spending the money," says Wendell Bailey, vice president for science and technology for the National Cable Television Association.

Also, HDTV could represent a way to wipe out cable TV's second-class image. In fact, if high-definition catches on in cable and videotape before the networks are ready to follow suit, "there's a very real threat that broadcasters will become secondary to other sources of video programming," says CBS's Stow.

The TV-broadcaster's nightmare can be summed up in one phrase: AM radio. Broadcasters fear that premium programming such as movies and sports—along with their lucrative advertising revenue—will migrate to alternative services that can display them in high definition. Broadcast TV then would devolve into a ghetto of talking heads, paralleling the fate of AM radio after FM's superior sound quality usurped the role of broadcasting music.

The reason broadcast HDTV will be the last to arrive at the party is simple.

Today's TV channels don't have enough room to carry an entire high-definition TV signal. In the United States and Japan, TV broadcasts still use a format set 40 years ago.

Ironically, this very problem spurred Japanese development of high-definition TV. Japan's NHK, the long-time champion of the technology, serves the entire country by broadcasting directly from a satellite, but also competes with local stations. NHK hoped to capture more viewers by transmitting a markedly superior picture.

Not surprisingly then, NHK's HDTV system was designed specifically for direct satellite transmission. True high-definition signals require about 30 megahertz of the frequency spectrum; standard TV stations are allotted only six megahertz each.

There are two basic approaches to the problem. One is to compress the HDTV signal, removing information that is redundant or that the eye does not easily notice. These systems reduce the amount of information in the signal so it can fit in a narrower bandwidth.

NHK uses the full 30-megahertz signal in the studio but has developed an abbreviated version for transmission. The technique for compressing the signal is called Muse, for multiple sub-Nyquist sampling encoding. Unfortunately, compressed signals produce pictures that

fall short of full high-definition glory. Muse, for example, degrades the quality of rapidly moving images. Moreover, Muse still needs a frequency span of more than eight megahertz, too wide for U.S. channels as they now stand.

Another signal-compression scheme, developed by the Del Rey Group, would cram a high-definition signal into six megahertz. This system would not force consumers to buy new TV sets, according to founder Richard Iredale; a conventional set tuned into a high-definition broadcast would show an ordinary image, but sets equipped with additional electronics and a wide screen would display the HDTV picture.

The Del Rey Group is a "very small fish in a big ocean," concedes Iredale. The company hopes to profit from its innovation by licensing it to broadcasters and TV manufacturers. But until standards are set, most set makers are "sitting on the fence," he says.

Del Rey is not the only organization working on a compatible system. In Japan, NEC is marketing a TV set that produces a distinctly superior picture even though it uses standard broadcast signals. This "improved definition" set works essentially by drawing every scan line twice, smoothing out the image without adding new information. Electronic circuitry compensates for motion in the scene. NEC sells a 27-inch improved-definition TV set for about \$2,500. The company presumably will bring the set to the U.S. market once glitches have been worked out in Japan.

U.S. makers will also compete. The David Sarnoff Research Center in Princeton, N.J., is promoting an idea it calls Advanced Compatible Television (ACTV). The Sarnoff Center—formerly RCA Laboratories and now a for-profit subsidiary of SRI International—is developing the system under a contract with General Electric. The NBC television network is also involved, as it was part of the package when General Electric bought RCA.

Like the Del Rey system, Sarnoff's ACTV uses one channel to send an up-graded signal. This makes it compatible with existing sets. However, the results can't match high-definition TV as developed by NHK. Indeed, Sarnoff's effort reveals how far away true broadcast high-definition TV is. "If it weren't for the pressure from the Japanese with Muse, we wouldn't even be talking about our system yet," admits Jim Carnes, Sarnoff's vice president for consumer

electronics and information science.

Sarnoff bills ACTV as a bridge between today's television and high-definition TV. The system works right now using available channels; prototype hardware will be demonstrated this year, says Carnes. Eventually, a second TV channel would be used to broadcast additional picture information, which the set would fold into the original channel to create a more detailed image. With the additional information sent over the second channel, the system would approach the quality of true HDTV. Carnes says RCA has spent \$45 million on ACTV in the last decade and \$30 million more will be needed to "make it real" over the next five years.

Several other high-definition schemes would require two channels from the start. A system from North American Philips would transmit a standard television signal on one channel and high-definition augmentation—additional detail as well as the "wings" that expand the square image—over a second channel. Existing TV sets would tune in to the standard channel and see an ordinary picture. An additional tuner on high-definition sets would pull in the high-definition channel, and extra circuitry would blend the two channels.

Philips has so far shown only computer simulations of its new system, but expects to field-test hardware by early next year, according to Arpad Toth, chief scientist at Philips Labs in Briarcliff Manor, N.Y.

Glenn of the New York Institute of Technology has already staged a preliminary demonstration of the hardware for a similar system. Like the Philips system, Glenn's scheme would send a conventional television picture over one channel and additional detail on a second channel. But Glenn's proposal compresses the signal to use only half of the second channel, thus preserving scarce spectrum space.

Glenn proposes sending the standard "coarse" signal at the usual 30 frames per second, but updating the high-definition detail at a slower speed: 15 or 7½ frames per second. He says viewers will still perceive a high-quality image, citing tests conducted by his wife—New York Institute of Technology researcher Karen G. Glenn—indicating that people cannot perceive rapid changes in fine detail.

Like Del Rey's Iredale, Glenn is a

small-time innovator in a struggle dominated by billion-dollar corporations. But whereas Iredale is his group's only employee, the New York Institute of Technology has a 20-person staff working on high-definition TV, with a budget of \$1 million a year. Keller of the National Association of Broadcasters says that Glenn's system outrates Japan's Muse and leaves Sarnoff's ACTV in the dust.

Though attractive, the two-channel approach raises another problem: Most of the radio-frequency spectrum is already spoken for. "With two channels, we can do really good high-definition TV," says Carnes. "But right now, two channels aren't available."

Even though HDTV is still years away, broadcasters have already tried to claim some unused UHF channels. These claims have resulted in a bitter clash with manufacturers of land mobile radios, which are widely used by police, fire, and ambulance services as well as by businesses ranging from pizza parlors and taxis to railroads and utilities. The mobile-radio community, led by equipment makers such as Motorola, says it needs these frequencies to support its growing industry.

In fact, the Federal Communications Commission was preparing to reallocate a slew of UHF frequencies for land-mobile use. However, stiff opposition from broadcast interests convinced the commission to shelve the plan, keeping the channels open for future use by high-definition TV. Reassigning these frequencies for mobile radio would be "like holding a gun to the head of local TV broadcasters and pulling the trigger," says broadcaster lobbyist DePriest.

The mobile-radio community is outraged, however. Without the reallocation, big cities such as New York, Chicago, and Los Angeles will run out of frequencies in three years, says Jack Richards, attorney for the Land Mobile Communications Council. "That's a high price just to give people sharper images of *Laverne & Shirley*," says Richards.

Spurred by this conflict, the FCC began last fall to assess how high-definition TV would affect the need for channels. The commission appointed an advisory committee that includes representatives of both broadcasters and TV-set manufacturers. The committee expects to issue a preliminary report this spring on how best to accommo-

HDTV SYSTEM SCORECARD

SYSTEM

ACTV

Glenn

HD-MAC

HD-NTSC

HDNTSC

IDTV

Muse

| ORIGINATOR | ADDRESS | WORKS ON EXISTING TVs? | DEVELOPMENT STAGE | COMMENTS |
|-------------------------------------|--|---------------------------|--|--|
| David Sarnoff Research Center | CN 5300 Princeton, NJ 08543 (609) 734-2507 | Yes | Computer simulation | Produces a wide-screen picture marginally better than conventional TV; later use of a second channel would provide a true high-definition picture. Uses one channel. |
| New York Institute of Technology | 800 North Ocean Dr. Dania, FL 33004 (305) 923-0551 | Yes | Demonstrated in closed- circuit form | Sends a conventional TV signal over one channel and a high-definition augmentation at a slower frame rate over a second channel. |
| Philips N.V. | The Netherlands | No | Demonstrated hardware | Europe's answer to Muse; for direct satellite broadcast. Needs multiple channels. |
| Del Rey Group | 8ax 9254 Marina Del Rey, CA 90292 (213) 301-8404 | Yes | Written proposal only | Takes three times longer than conventional TV to update display, and thus would smear moving images. Uses one channel. |
| North American Philips | 345 Scarborough Rd. Briarcliff Manor, NY 10510 (914) 945-6000 | Yes | Field test due in late 1988 or early 1989 | Sends a standard TV signal over one channel and high-definition detail in an unused UHF channel. For terrestrial broadcast, unlike system from Philips N.V. |
| NEC Home Electronics | 1255 Michael Dr. Wood Dale, IL 60191 (312) 860-9500 | Yes | IDTV sets already on Japanese market for about \$2,500 | Repeats scan lines to emulate high definition; motion-compensation circuitry reduces picture smear. Uses one channel. |
| Japan Broadcasting (NHK) | 1 Rockefeller Plaza New York, NY 10020 (212) 489-9550 | No | Hardware prototypes built; sets could reach U.S. in 1990 | For direct satellite broadcast; picture quality suffers when image moves rapidly. Terrestrial transmission requires multiple channels. |

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MATT ZANG

date the new technology. In addition, the FCC has requested industry comment on the future of television broadcasting technology.

Despite the FCC's new interest, the battle for standards and spectrum will no doubt rage into the early 1990s. The Japanese have an immense head start because they have built an operating system. The real test will begin in about two years, when high-definition gear using the Muse format comes out for consumers. No one knows how much people are willing to pay for a clearer picture, and a high-definition TV set may well cost several times the price of a conventional set.

If a competing system arrives on the market, the Japanese may find themselves paddling upstream. Muse's utter incompatibility with the current video format could become an albatross; consumers would almost certainly prefer high-definition programming in a form that ordinary TV sets can tune into, just as black-and-white sets can receive color broadcasts.

Unfortunately, the introduction of HDTV is a bit more chaotic than was the introduction of color, which had the support of the country's dominant TV manufacturer, RCA, and one of the major networks, NBC. No similar alliance exists to push high-definition TV into America's living rooms; NBC, which is sponsoring the Sarnoff laboratory system, is now owned by GE—which no longer manufactures televisions.

The Japanese will almost certainly introduce Muse products in the United States by 1990. But the sets will be expensive and of limited use. Unless the networks start broadcasting in the new high-definition format, the Muse equipment will work to its full potential only with a few leading-edge videotapes, videodisks, and cable programs.

However, that need not be the end of the story. The U.S. television business could assert itself with concerted action by set manufacturers, networks, and cable programmers. If these three arms of the television industry choose to push a format other than Muse—the

Glenn system, for example—Japan's would-be high-definition standard could crumble of its own inadequacies. Some observers believe that the FCC and Congress will step in to create a combination system, culling the best features of several technologies.

These scenarios play out only if more spectrum becomes available; other than the Sarnoff Center and the Del Rey Group, few people believe that worthwhile improvements in the TV picture are possible if broadcasters are confined to the same slim channels they now occupy. But any move to allot broadcasters more frequencies will be vigorously opposed. The early 1990s, therefore, may prove to be a transition period during which high-definition TV is available on cable and pre-recorded tapes and disks, but not over the air.

The day when flipping on the TV set brings crisp, movie-like pictures is still a few years off. But the players are on the field, the rules are taking shape, and the spectators are waiting in the stands. Stay tuned. ■

SOURCE: HIGH TECHNOLOGY BUSINESS RESEARCH

THE HIGH TECHNOLOGY BUSINESS LEADING 100

| COMPANY (SYMBOL/EXCHANGE) | RANK THIS MONTH/ LAST MONTH | PRICE INCREASE LAST MONTH (%) | CLOSING PRICE (\$) | EARNINGS PER SHARE | | LATEST DIVIDEND (\$) | P/E RATIO | DEBT/ EQUITY RATIO | LATEST 12 MONTHS' REVENUE (IN MILLIONS) |
|---------------------------------|-----------------------------------|---|--------------------------|----------------------|---------------------------|-------------------------|-----------|--------------------------|---|
| | | | | LAST QUARTER (\$) | CHANGE FROM 1 YEAR AGO | | | | |
| AEROSPACE | | | | | | | | | |
| Boeing (BA/NYSE) | 1/20 | 19.4 | 46.25 | .92 | -25.2 | 1.40 | 14.9 | .05 | 15,355.0 |
| Sequo (SQAB/NYSE) | 2/11 | 13.9 | 59.25 | NA | NA | .50 | NA | NA | NA |
| Northrop (NOC/NYSE) | 3/27 | 13.7 | 30.00 | .73 | NE | 1.20 | 19.2 | .04 | 5,944.4 |
| Rahr Ind. (RHR/NYSE) | 4/24 | 11.9 | 20.00 | .40 | -20.0 | — | 14.0 | .43 | 707.5 |
| Sierrocin (SER/AMEX) | 5/30 | 11.1 | 5.00 | .20 | 42.9 | — | 13.9 | .38 | 73.5 |
| Sequo (SQAA/NYSE) | 6/9 | 10.0 | 56.63 | 1.56 | 66.0 | .60 | 2.8 | .43 | 976.5 |
| ARX (ARX/NYSE) | 7/23 | 6.6 | 8.13 | .21 | 10.5 | — | 8.0 | .87 | 63.7 |
| Utd. Technal. (UTX/NYSE) | 8/12 | 6.5 | 37.13 | 1.32 | NE | 1.40 | 8.2 | .45 | 17,170.2 |
| Gen. Dynamics (GD/NYSE) | 9/4 | 6.4 | 53.75 | 2.27 | NE | 1.00 | 5.2 | .34 | 9,344.0 |
| Martin Marietta (ML/NYSE) | 10/15 | 6.4 | 45.75 | 1.12 | 23.1 | 1.10 | 10.8 | .27 | 5,165.1 |
| CHEMICALS | | | | | | | | | |
| Mycogen (MYCO/NASDAQ) | 1/80 | 47.4 | 7.00 | -.14 | NC | — | NE | .04 | 1.7 |
| Aceto (ACET/NASDAQ) | 2/66 | 20.8 | 14.50 | .25 | 25.0 | .14 | 13.3 | .17 | 100.0 |
| Intl. Genetic (IGEI/NASDAQ) | 3/72 | 20.0 | 3.00 | -.08 | NE | — | NE | .00 | 1.9 |
| Hyponex (HYPX/NASDAQ) | 4/78 | 18.2 | 6.50 | -.11 | NE | — | 11.0 | .88 | 122.9 |
| Ausimant Camp. (AUS/NYSE) | 5/49 | 11.6 | 15.63 | .35 | 6.1 | .48 | 8.7 | .25 | 730.5 |
| Betz Labs (BETZ/NASDAQ) | 6/47 | 10.0 | 46.75 | .65 | 44.4 | 1.52 | 18.1 | .00 | 385.9 |
| Borden Chem. (BCP/NYSE) | 7/57 | 8.4 | 12.88 | NA | NA | — | NA | NA | NA |
| Ethyl (EY/NYSE) | 8/30 | 7.1 | 20.75 | .44 | 4.8 | .44 | 13.2 | .43 | 1,720.3 |
| Georgia Bonded (GBFH/NASDAQ) | 9/73 | 7.1 | 3.75 | .22 | NE | — | 7.5 | .08 | 59.1 |
| Ecogen (ECN/AMEX) | 10/4 | 6.6 | 6.00 | -.21 | NE | — | NE | .25 | 3.7 |
| COMMUNICATIONS | | | | | | | | | |
| TVX Broadcast (TVXG/NASDAQ) | 1/65 | 36.4 | 3.75 | -2.33 | NE | — | NE | 12.85 | 64.1 |
| West. Tele. (WTLCA/NASDAQ) | 2/50 | 30.0 | 16.25 | .06 | -84.6 | — | 22.3 | 4.92 | 82.3 |
| ALC Comm. (ALCC/NASDAQ) | 3/55 | 28.6 | 2.25 | NC | NC | — | NE | 2.39 | NC |
| West. Telecom. (WTLB/DTC) | 4/45 | 25.7 | 15.25 | NA | NA | — | NA | NA | NA |
| Acton (ATN/AMEX) | 5/59 | 16.7 | 15.75 | -.18 | NE | — | 3.3 | 2.18 | 30.8 |
| Utd. Telcam. (UT/NYSE) | 6/47 | 16.5 | 29.13 | .23 | -53.1 | 1.92 | NE | 1.56 | 1,812.6 |
| MCI (MCIC/NASDAQ) | 7/28 | 15.2 | 11.38 | .15 | NE | — | 37.9 | 2.12 | 3,939.0 |
| TPI Enter. (TELE/NASDAQ) | 8/14 | 14.6 | 5.88 | .02 | NE | — | NE | .00 | 3.0 |
| Checkpoint Sys. (CHK/NASDAQ) | 9/5 | 14.3 | 8.00 | .10 | -64.3 | — | 36.4 | .12 | 35.4 |
| Eagle Telephonics (EGLA/NASDAQ) | 10/62 | 13.6 | 1.00 | .01 | -66.7 | — | 9.1 | .12 | 38.6 |
| COMPUTERS | | | | | | | | | |
| Comp. Identics (CIDN/NASDAQ) | 1/187 | 112.3 | 2.25 | -.05 | NE | — | NE | .00 | 11.8 |
| Zitel (ZITL/NASDAQ) | 2/149 | 50.0 | 3.00 | .04 | NE | — | 37.5 | .09 | 18.0 |
| CMS Enhance. (ACMS/NASDAQ) | 3/154 | 47.6 | 4.25 | .04 | -33.3 | — | 20.2 | .00 | 110.9 |
| Iomega (IOMG/NASDAQ) | 4/81 | 46.3 | 2.75 | .15 | 400.0 | — | NE | .13 | 89.4 |
| Rodime (RODMY/DTC) | 5/153 | 45.2 | 3.63 | .04 | NE | — | NE | .06 | 71.8 |
| Microoge (MICA/NASDAQ) | 6/122 | 42.6 | 6.06 | .26 | 73.3 | — | 7.4 | .27 | 218.7 |
| Franklin Comp. (FDOS/NASDAQ) | 7/102 | 30.0 | 14.63 | .29 | NE | — | 38.5 | .47 | 39.5 |
| Star Tech. (STRR/NASDAQ) | 8/116 | 25.0 | 2.50 | .02 | -33.3 | — | 20.8 | 3.50 | 42.1 |
| Compucom Sys. (BYTE/NASDAQ) | 9/134 | 21.4 | 2.50 | -.07 | NE | — | NE | .61 | 2.1 |
| Selecterm (SLTM/NASDAQ) | 10/115 | 21.4 | 4.25 | .08 | -27.3 | — | NM | .00 | 23.5 |
| DRUG MANUFACTURERS | | | | | | | | | |
| Ouromed Phar. (ORMD/NASDAQ) | 1/85 | 89.1 | 4.50 | -.84 | -100.0 | — | NE | .94 | 20.3 |
| Ventrex Labs (VTRX/NASDAQ) | 2/15 | 66.0 | 1.56 | -.03 | NE | — | NE | .17 | 11.6 |
| Cooper Oevel. (BUGS/NASDAQ) | 3/76 | 58.1 | 12.25 | -1.62 | NE | — | NE | 5.37 | .1 |
| Pharmocontrol (PHAR/NASDAQ) | 4/31 | 57.1 | 2.75 | -.42 | NE | — | NE | 2.40 | 7.7 |
| Sterling Drug (STY/NYSE) | 5/28 | 55.6 | 88.50 | 1.03 | 18.4 | 1.52 | 26.6 | .21 | 2,232.1 |
| Incstar (ISR/AMEX) | 6/58 | 52.1 | 4.00 | NC | NC | — | 44.4 | .12 | NC |
| Biotechnica Int. (BIOT/NASDAQ) | 7/70 | 45.5 | 4.00 | -.50 | NE | — | NE | 2.97 | 5.7 |
| Rorer Group (RDR/NYSE) | 8/52 | 32.0 | 49.50 | .62 | NE | 1.20 | 42.3 | 1.14 | 916.7 |
| App. Bioscience (APBI/NASDAQ) | 9/25 | 28.9 | 12.25 | .23 | 64.3 | — | 15.3 | 4.66 | 30.8 |
| E Z EM (EZEM/NASDAQ) | 10/68 | 27.2 | 12.25 | .24 | 60.0 | — | 15.1 | .00 | 54.1 |

■ MARKETWATCH ■

The following are the 10 companies in each of 10 industries that had the highest stock gain over the previous month (figures as of 2/4/88).

NA = Not available NE = Negative earnings NC = Not calculable NM = No meaningful figure

| COMPANY (SYMBOL/EXCHANGE) | RANK THIS MONTH/ LAST MONTH | PRICE INCREASE LAST MONTH (%) | CLOSING PRICE (\$) | EARNINGS PER SHARE | | LATEST DIVIDEND (\$) | P/E RATIO | DEBT/ EQUITY RATIO | LATEST 12 MONTHS' REVENUE (IN MILLIONS) |
|---------------------------------------|-----------------------------------|---|--------------------------|----------------------|---------------------------|-------------------------|-----------|--------------------------|---|
| | | | | LAST QUARTER (\$) | CHANGE FROM 1 YEAR AGO | | | | |
| ELECTRONICS | | | | | | | | | |
| Eldec (DGT/NASDAQ) | 1/167 | 126.1 | 2.69 | -.44 | NC | — | NE | .06 | 8.6 |
| New Century Ent. (NUCP/NASDAQ) | 2/57 | 119.0 | 1.38 | -.49 | NE | — | NE | 1.55 | 34.1 |
| Morgoux (MRGX/NASDAQ) | 3/222 | 47.2 | 1.56 | .09 | NE | — | NE | .23 | 17.9 |
| Robotic Vision (RDBV/NASDAQ) | 4/228 | 44.4 | 4.88 | .00 | NE | — | NM | .00 | 14.8 |
| Astrocom (ACDM/NASDAQ) | 5/242 | 44.0 | 1.44 | -.04 | -100.0 | — | NE | .26 | 12.1 |
| Tech. Comm. (TCCD/NASDAQ) | 6/100 | 42.9 | 5.00 | .18 | NE | — | 55.6 | .00 | 3.3 |
| Polk Audio (POLK/NASDAQ) | 7/202 | 38.9 | 6.25 | .16 | 33.3 | — | 9.8 | .00 | 19.0 |
| Tridex (TDX/AMEX) | 8/142 | 38.9 | 4.00 | .09 | 50.0 | — | NE | 7.64 | 19.8 |
| Lowrance Elec. (LEIX/NASDAQ) | 9/216 | 38.5 | 4.50 | -.32 | -100.0 | — | 23.7 | .07 | 41.3 |
| Circon (CCDN/NASDAQ) | 10/146 | 37.7 | 4.13 | .06 | NE | — | NE | .32 | 41.4 |
| HEALTH | | | | | | | | | |
| Genetic Lab (GENL/NASDAQ) | 1/107 | 77.0 | 2.00 | -.08 | NE | — | 20.0 | .19 | 4.0 |
| Electro Catheter (ECTH/NASDAQ) | 2/114 | 61.3 | 3.63 | -.04 | NE | — | NE | .00 | 8.5 |
| Diosonics (DNIC/NASDAQ) | 3/39 | 53.2 | 2.88 | .04 | 100.0 | — | NE | .41 | 258.6 |
| Phoenix Med. (PHNX/NASDAQ) | 4/67 | 50.0 | 10.50 | .11 | NE | — | 31.8 | .89 | 12.6 |
| Mono. Antibod. (MABS/NASDAQ) | 5/81 | 46.9 | 3.13 | -.33 | NE | — | NE | .07 | 5.6 |
| Inmed (NMEDE/NASDAQ) | 6/110 | 42.9 | 2.50 | -.23 | NE | — | NE | .39 | 9.0 |
| Electro Nucleonic (ENUC/NASDAQ) | 7/102 | 39.3 | 9.75 | .03 | NE | — | NE | .25 | 66.5 |
| Vestor (VSTR/NASDAQ) | 8/96 | 38.9 | 6.25 | -.18 | NE | — | NE | .00 | 2.2 |
| Dento Med. (DTMO/NASDAQ) | 9/71 | 35.2 | 1.69 | -.02 | NE | — | NE | .00 | .1 |
| Everest & Jen. (EJB/AMEX) | 10/104 | 34.9 | 11.13 | -.01 | -100.0 | .10 | NM | .52 | 203.4 |
| METALS FABRICATION | | | | | | | | | |
| Struthers Wells (SUW/AMEX) | 1/41 | 58.7 | 1.00 | .01 | NE | — | NE | .28 | 10.7 |
| Howell Ind. (HOW/AMEX) | 2/37 | 52.2 | 25.50 | 1.14 | 70.1 | .50 | 7.3 | .06 | 45.2 |
| Edgecomb (EDGC/NASDAQ) | 3/40 | 47.1 | 3.50 | .06 | NE | — | NE | 3,318.54 | 545.5 |
| Moog (MOGB/AMEX) | 4/24 | 34.6 | 14.13 | NA | NA | .20 | NA | NA | NA |
| Exposaic Ind. (EXPO/NASDAQ) | 5/22 | 33.3 | 12.50 | .53 | 89.3 | .24 | 7.7 | .99 | 193.3 |
| Groff Ind. (GRDF/NASDAQ) | 6/33 | 30.0 | 13.00 | .46 | 187.5 | .16 | 13.5 | .00 | 34.3 |
| Cronus Ind. (CRNS/NASDAQ) | 7/16 | 29.8 | 13.63 | .10 | -98.2 | — | NE | .20 | 42.5 |
| Sifco Ind. (SIF/AMEX) | 8/18 | 26.2 | 9.63 | .31 | 342.9 | .15 | 8.1 | .37 | 67.3 |
| Metex (MTX/AMEX) | 9/35 | 23.3 | 9.25 | .18 | 80.0 | — | 9.2 | .21 | 29.9 |
| Met-Coil Sys. (METS/NASDAQ) | 10/31 | 22.4 | 4.75 | .26 | NE | .12 | 15.3 | .64 | 51.3 |
| SCIENTIFIC AND ELECTRONIC INSTRUMENTS | | | | | | | | | |
| Galileo Elec. (GAEO/NASDAQ) | 1/93 | 40.7 | 9.50 | .03 | -75.0 | — | 16.7 | .00 | 35.8 |
| Micron Prods. (PMR/AMEX) | 2/84 | 39.9 | 2.63 | .06 | .0 | — | 11.9 | .21 | 4.0 |
| FBX (FBXC/NASDAQ) | 3/99 | 38.1 | 1.56 | -.03 | -100.0 | — | 39.1 | .17 | 13.4 |
| Photonics (PHOT/NASDAQ) | 4/74 | 37.7 | 5.00 | .13 | -23.5 | — | 6.8 | .73 | 14.3 |
| IRT (IX/AMEX) | 5/16 | 37.5 | 2.75 | -.35 | NC | — | NE | 1.62 | 38.7 |
| Panatech R&D (PNTC/NASDAQ) | 6/69 | 30.2 | 1.38 | -.04 | NE | — | NE | .35 | 13.9 |
| Vonzetti Sys. (VANZ/NASDAQ) | 7/91 | 26.8 | 1.75 | .04 | NE | — | NE | .25 | 3.5 |
| Beor Auto Svc. (BEAR/NASDAQ) | 8/26 | 25.0 | 5.00 | -.26 | -100.0 | — | 83.3 | .63 | 88.3 |
| Brinkmann Inst. (BRIK/NASDAQ) | 9/67 | 23.7 | 9.75 | .36 | 111.8 | — | 11.3 | .00 | 63.4 |
| MTS Sys. (MTSC/NASDAQ) | 10/85 | 17.7 | 18.25 | .27 | 107.7 | .24 | 43.5 | .23 | 113.6 |
| SOFTWARE AND DATA PROCESSING | | | | | | | | | |
| Bio Logic Sys. (BLSC/NASDAQ) | 1/61 | 43.8 | 5.75 | .09 | 80.0 | — | 21.3 | .22 | 7.9 |
| Intermetrics (IMET/NASDAQ) | 2/104 | 38.9 | 4.00 | .10 | 233.3 | — | 14.3 | .13 | 47.0 |
| Scitex (SCIX/NASDAQ) | 3/118 | 35.2 | 2.88 | .09 | NE | — | NE | .26 | 158.4 |
| Scientific Sys. (SSSV/NASDAQ) | 4/81 | 33.0 | 2.50 | .03 | 50.0 | — | 16.7 | .11 | 12.1 |
| Cycore Sys. (CYCR/NASDAQ) | 5/113 | 29.2 | 7.75 | .19 | 46.2 | — | 14.4 | .15 | 64.4 |
| Ask Comp. Sys. (ASKI/NASDAQ) | 6/85 | 28.6 | 10.13 | .18 | 20.0 | — | 15.6 | .01 | 115.8 |
| Gen. Computer (GCCC/NASDAQ) | 7/100 | 28.6 | 11.25 | .04 | NE | — | 21.2 | .00 | 16.4 |
| CMX (CXC/AMEX) | 8/135 | 28.4 | 1.13 | .03 | 50.0 | — | 10.2 | .26 | 12.6 |
| Pento Sys. Int. (PSLI/OTC) | 9/137 | 22.7 | 2.00 | .08 | 300.0 | — | NE | .13 | 21.2 |
| Computroc (LLB/AMEX) | 10/54 | 21.7 | 2.13 | -.17 | -100.0 | .07 | NE | .11 | 7.7 |

SOURCE: MEDIA GENERAL FINANCIAL SERVICES

New Pagers Put a Mailbox In Your Pocket

*Advances in pager technology prompt renewed interest
from telecommunications entrepreneurs*

BY ALAN A. REITER

THE STOCK market starts to plummet and your broker is trying desperately to reach you, but you've just left for a leisurely lunch.

Your company can grab a \$1-million sales order if you approve the financing today, but for the next two hours you'll be driving to an appointment in a neighboring state.

The fan in your chicken coop just failed and unless it's fixed in less than an hour, all 10,000 chickens will die of heat stroke.

If only you had known.

With an alphanumeric radio pager, you could have known.

Alphanumeric pagers, the most sophisticated type of "beeper," are just beginning to capture the attention of telecommunications entrepreneurs. Although these "alpha" pagers still represent the smallest segment of the \$1.5-billion radio-paging market, the sophisticated devices can do much more than alert people to call the office.

Most observers agree that the range of possible applications for alpha pagers has hardly been scratched. The promise of the devices rests on their unparalleled ability to handle messages and on their flexibility. Unlike simpler pagers, alpha pagers can take

detailed messages, receive information automatically from remote databases, and monitor the status of equipment. Essentially, the devices let people carry an electronic mailbox in their pocket.

"I think the market has not yet understood the benefits of alphanumeric [paging]," says Bob Spargo, Motorola's director of marketing for the subscriber paging market.

When Motorola introduced the first alpha pager, Optrx, to the U.S. market in 1983, the company assumed it would be used in the same way as other pagers. But the product met a cool reception; traditional pager users found they didn't need the text messages it offered. "People are not willing to pay 50 percent more just to see words," Spargo says. "But they will pay 100 to 200 percent more for information...We just don't know what."

The farther business people stray

from the office, the more they need detailed information, says Larry Anderson, national marketing manager for Metrocast, the first national paging service to offer alphanumeric pagers. The typical Metrocast subscriber is male, 40 to 50 years old, with an annual income of at least \$50,000. Unlike local paging subscribers, most nationwide customers hold top management positions and at least 50 percent have never used a pager before, notes Anderson. For this type of upscale subscriber, he says, "alphanumeric is the future of nationwide paging."

But despite its advantages, alphanumeric paging has been considered the black sheep of the paging industry. Alpha pagers comprise less than 1 percent of the market, or about 52,000 units. Revenues from these devices approach \$25 million per year.

One reason alpha pagers represent such a small share of the overall paging market is that they are harder to sell than simpler pagers. Alpha pagers weigh an ounce or two more and are somewhat larger than other pagers, and they're much more expensive. The least expensive type of beeper pager—a "tone-only" unit—sells for \$49 to \$150; alpha pagers cost about \$375 to \$475.

A lease-and-service contract

ALPHA-PAGER MAKERS

Motorola
Communications Sector
1301 E. Algonquin Rd.
Schaumburg, IL 60196
(312) 397-1000

NEC America
4936 W. Rosecrans Ave.
Hawthorne, CA 90250
(213) 973-2071

Philips Telecom Equipment
Box 458
Maitland, FL 32751
(305) 740-6655

Multitone Electronics
1 Cornell Parkway
Springfield, NJ 07081
(201) 467-1800

Panasonic Industrial
1 Panasonic Way
Secaucus, NJ 07094
(201) 348-7000



DANIEL PELAVIN

for a beeper pager costs about \$10 to \$15 per month, but leasing and service charges for alpha pagers can run almost four times that, from \$35 to \$45 per month. The high service fees result from alpha pagers' hunger for bandwidth. Paging companies can fit 100,000 to 150,000 beeper pagers on one channel, but only about one-tenth that number of alphanumeric pagers. The more advanced devices "get to be airtime hogs if you're sending a lot of data often," says Stan Sech, senior vice president and general manager of Graphic Scanning's paging division. As a result, many paging operators resist offering alpha pagers, and customers often find it hard to obtain voice paging in crowded metropolitan markets.

But perhaps the biggest impediment to the growth of alphanumeric paging is the relative inconvenience of entering messages.

With simpler pagers, callers can use a standard touch-tone phone to send a beep, relay a

voice message, or enter a phone number. The information travels over phone lines from the telephone to the paging company's terminal. The terminal then sends the page to an antenna, which broadcasts it to the pager.

However, to send alphanumeric messages callers generally need access to a computer keyboard or operator assistance. (One company, UniPage of DeSoto, Tex., sells a paging terminal that lets callers send alphanumeric messages by using the telephone's keypad along with the * and # keys. The system, meant for occasional use or emer-

gency situations, is too awkward for daily use.)

In the simplest method, used by service providers such as Metrocast, callers contact the paging company, where an operator types the message into a computer system. But relaying a message through an operator is expensive for the paging company, and that cost gets passed on to customers. Subscribers who buy Metrocast's \$450 pager also pay \$35 to \$50 per month for unlimited numeric messages. Subscribers who lease the pager pay a monthly fee of \$50 to \$70. The additional charge for alphanumeric messages averages \$15 to \$20 a month.

Many paging companies find operators "a labor-intensive headache," says Graphic Scanning's Sech. As a result, more and more companies are supplying customers with telecommunications software for their personal computers.

Metriplex Systems of Cambridge, Mass., is a pioneer in developing software for alpha

ALPHA-PAGER FEATURES

| SYSTEM | MEMORY (characters) | MESSAGE SIZE (characters) | NUMBER OF MAILBOXES | DISPLAY SIZE (characters) |
|-----------|------------------------|------------------------------|------------------------|------------------------------|
| Motorola | 1,984 | 1,950 | 16 | 2 lines of 16 |
| Panasonic | 1,000 | 400 | 20 | 1 line of 16 |
| Philips | 512 | 512 | 9 | 1 line of 16 |
| Multitone | 500 | 500 | Depends on memory | 1 line of 16 |
| NEC | 416 | 352 | 12 | 1 line of 16 |

SOURCE: HIGH TECHNOLOGY BUSINESS RESEARCH

PAGERS IN SERVICE

(All types)

6 million

5 million

4 million

3 million

2,800,000

1983

1984

1985

1986

1987

ALPHA PAGERS IN SERVICE

50,000

40,000

30,000

20,000

5,000

12,000

25,000

35,000

52,000

SOURCE: HIGH TECHNOLOGY BUSINESS RESEARCH

paggers. The company was founded by brothers Marc and Steve Stutman. Marc Stutman first started thinking about paging when he lost a potential \$8,000 profit in the options market because his broker couldn't reach him. After determining that the major technical stumbling block to alphanumeric paging was a lack of easy-to-use communications software, the Stutmans developed a program called PcPage that lets users send messages from IBM PC-compatible computers to a paging company's terminal. Metriplex has sold more than a thousand copies of the \$195 program. Another company, Fitzgerald Telecommunications of Euclid, Ohio, offers a similar \$69 program for IBM PC and compatible computers.

For big customers, direct communication makes a lot of sense. Roger Alley, priority-accounts manager for Dial Page of Charlotte, N.C., says his company has about 400 alpha-pager customers on the system—in large part because of PcPage. Alley calls alpha paging "a radically new way to communicate."

One of Dial Page's largest alpha users is Coca-Cola Bottling Consolidated. Kevin Black, an area route manager for Coca-Cola, says alpha paging has improved the efficiency of deliveries by 10 percent. Sales have increased because customers know items will be delivered when promised, or faster, Black says.

Coke dispatchers take customer orders over the phone and then transmit the customer's identification number, product code, and order to the delivery truck. Black says the alpha receivers are far superior to the tone-and-voice units the company used to use; road noise often drowned out the voice message. Alpha units are also safer. Because the pager stores the data, drivers don't have to take their eyes off the road to write down the information.

Black also gives his pager number to customers so they can reach him quickly. "To me, it's a godsend," he says. "I've never been more satisfied with any communications tool."

Alphanumeric pagers lend themselves to broadcast applications as well, with the transmission of financial information offering the biggest opportunity. Supplying financial information represents an entirely new market niche for the radio-paging industry.

Metriplex, which expects to be an \$8-million company by the end of the year, has developed software called Portfolio

Plus that lets brokers provide financial quotations for clients. The personal-computer package automatically taps databases of financial information to provide quotes on stocks, commodities, options, and other items. The service costs the customer between \$80 and \$250 per month.

Broker Bill Wiseman of E.F. Hutton in Boston uses the system to stay in contact with clients. Wiseman says it reduces a great deal of stress when trying to contact them and adds an element of fairness. With the paging system, he can contact clients simultaneously and avoid accusations of playing favorites with news of the market.

Denver-based Intelligent Quotations began testing a similar stock service last year and plans to provide commercial service early this year. President Dennis Roland says the company's standard service will be cheaper and will provide data on as many as eight securities, updated eight times a day.

Intelligent Quotations plans to sell this basic service to paging companies for a monthly fee of \$15 to \$25 per user. But subscribers will also have to pay an additional \$5 per month for each market monitored, and paging operators can mark up the service at their discretion.

Another popular service is expected to be transmitting sports scores. Beeper Plus of Las Vegas has about 2,000 subscribers to its Sports Page service in about 10 states, says Bill Nelson, one of the founders. The service updates as many as 80 games every five minutes and uses Motorola PMR2000 pagers, which subscribers buy for \$300 to \$395, depending on location. Users also pay a monthly fee of \$45 to \$65, says general manager Maria Fleming. She expects the number of Sports Page customers to double by the end of the year.

One fan of the service is California sportscaster Larry Kahn. "It provides a lot of information," says Kahn, who adds that the data is often more current than that of other sports services.

Beeper Plus is also testing a consumer-oriented alphanumeric package. Nelson says the service, which should be available by mid-1988, will include at least four services for less than \$10 per month. The services will include market reports, news headlines, and weather.

Omni Communications of Lynn, Mass., a radio common carrier with more than 51,000 pagers in the field, is taking this package concept a step further. Omni began testing a sports-data

HOW THE NEW PAGERS WORK

Alphanumeric pagers are the peak of pager technology. Their predecessors are tone pagers that supply only a beep, tone-and-voice devices that let callers send a spoken message along with the beep, and numeric-display pagers that accept only phone numbers. These earlier types currently own 99 percent of the paging market; alphanumeric models that can display numbers and letters are just getting started. But the ability of alpha models to act as electronic mailboxes gives them the potential to eventually dominate the market.

Pagers have been shrinking ever since they were introduced, but alpha pagers are larger than their simpler cousins and weigh 3½ to 5 ounces. Alpha units can store 416 to 1,984 characters, more than a page of text.

Most alpha pagers are designed to receive various types of messages from different sources, so most high-end models divide their memory space into "mailboxes," each holding a message. When all the mailboxes are filled, the next message replaces the oldest message. Some pagers have several "protected mailboxes" that cannot be automatically erased.

Several kinds of service companies send messages to pagers. These services vary from local companies with one transmitter covering 20 or 30 miles to regional outfits with dozens of transmitters covering several states.



Motorola's PMR 2000 pager.

Several nationwide companies offer paging from coast to coast, but coverage consists of service "islands" that leave many gaps.

Most paging services are simple to use. For a tone-only page, callers dial the service's phone number, listen for the beep, and hang up. For a tone-and-voice page, callers listen for the beep, speak for six to ten seconds, and hang up after the cutoff tone. Sending a numeric page involves listening for the beep and using the telephone keypad to enter the number. Alpha pagers generally require callers to enter the message on a computer terminal, or relay the message through the service's operator.

Regardless of pager type, telephone lines deliver the message to the paging company's terminal. After the terminal identifies the pager number as being in service, it places the page in a queue and transmits the message to one or more antennas that broadcast the information on the FM band. A special address, or cap code, in the message alerts the particular pager to receive the message.

Most paging broadcast systems are analog, but the greater speed of digital broadcasts is making them increasingly popular. Digital broadcasts are also easier to integrate into other telecommunications services, especially data communications.

transmission service in the Boston area in September, and president Anthony DiCrocce expects to offer the service commercially in the Boston, New York, and Baltimore/Washington markets later this year. But sports is only part of DiCrocce's plan. He compares alphanumeric paging to the cable-TV industry and expects to offer customers a variety of services combined into package deals at a special price.

Despite the optimism about such services, another Las Vegas company, MiniScoreboard, decided to suspend operation of its sports-information service last year, says director of engineering Andy Pope. The company hopes to reenter the market on a national basis if it can strike appropriate deals with a national operation or local providers.

Electronic monitoring is not as glamorous as financial information or sports, but it might develop into at least as important a business for the paging industry. Currently, remote sensors in offices, factories, farms, and power plants watch over heating and air-conditioning systems, industrial processes,

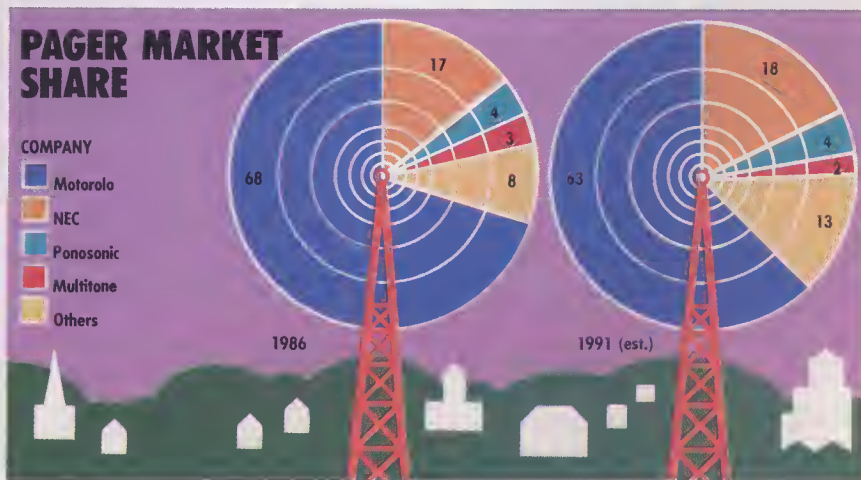
and security monitors. When these sensors detect a change, they could transmit a signal to send a preprogrammed alphanumeric message to a pager.

PageWatch, a division of Scarsdale Security Systems in Mamaroneck, N.Y., recently announced an alarm-monitoring system that uses pagers. When a sensor sends an alarm over telephone lines to PageWatch's computer,

the system sends a stored message to the paging company's terminal for transmission to a pager.

Another service, from Zetron of Bellevue, Wash., will use a similar system to send voice messages to two-way radios. The service, called SentiPage, could also send preprogrammed alphanumeric messages to pagers.

Despite the proliferation of new ap-



SOURCE: FROST & SULLIVAN

THE FUTURE OF PAGING

The first page was supposedly received by a doctor on a golf course in 1950.

Whether this industry legend is true or not, doctors remain prime subscribers to paging services. Other major users include salespeople, real-estate agents, construction workers, repair technicians, couriers, police officers, and firefighters. Dentists with offices in shopping malls give pagers to waiting patients so they can shop until called by the beep. Worried fathers-to-be lease pagers so their wives can tell them it's time to rush to the hospital. Patients awaiting transplants may carry pagers for months, longing for the tone that means a donor organ is available. Pagers have even entered the seamier side of the "business world," where prostitutes and drug dealers are frequent subscribers.

Since that first page on the links, the paging industry has grown to include more than 6.5 million units in service over systems owned by telephone companies, private carriers, and radio common-carriers, according to the consulting firm Arthur D. Little. Based on an average \$20 per month charge to consumers for equipment leasing and service, radio paging has become a \$1.56 billion industry.

U.S. paging companies have established offices in more than 1,300 locations serving more than 4,900 cities and towns, according to Telocator Network of America, a paging and cellular-telephone trade association in Washington. But as paging use has grown, the number of paging companies has shrunk. Once the province of small outfits, the Bell operating companies and other telephone-industry giants have been snapping up local paging operations left and right. Observers say this consolidation will probably continue, because the top five paging-service compa-

nies still hold only about a third of the total market.

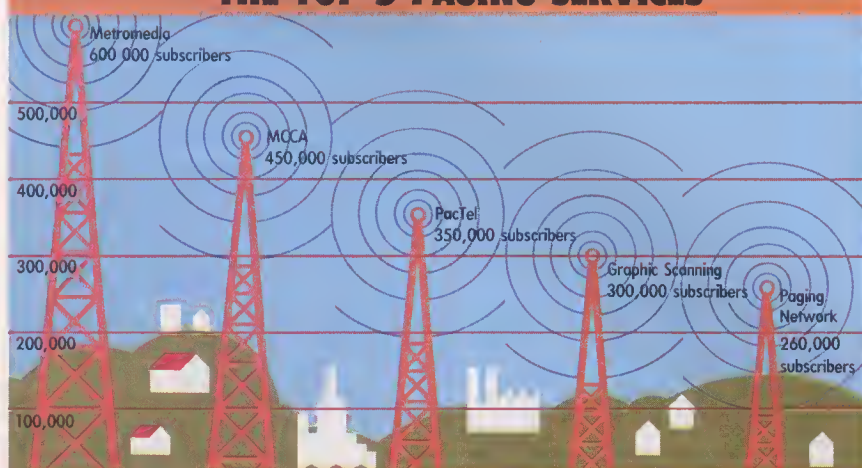
Prices have also been falling, prompting paging companies to offer more advanced services to maintain profit margins. In one common strategy, local and regional vendors work together to extend paging service across wider areas.

The industry's future may depend on its ability to integrate pagers with other communication technologies such as voice mail, electronic mail, and facsimile machines. Among the companies developing systems to do just that is Washington's National Satellite Paging, which has signed an agreement with GeoNet Mailbox Systems of Alexandria, Va., to offer electronic mail to National's subscribers. Also, Metriplex Systems has teamed with Stratus Computer of Marlboro, Mass., to develop a paging switch to integrate mobile and fixed voice and data services.

When integration is complete, subscribers will be able to receive messages in several ways. For example, personal-computer users could send a text message to the subscriber's general-purpose mailbox, which would store it both as text and as a digitized voice. The mailbox would automatically transmit the text version to the subscriber's alpha pager. Subscribers without their pagers could phone the mailbox and hear the voice-synthesized version. The message could also be accessed with another personal computer or sent to a fax machine.

On the consumer side, later this year AT&E Corp. of San Francisco and Japanese watchmaker Hattori Seiko plan to unveil a long-delayed prototype of an inexpensive numeric pager built into a wristwatch. AT&E has been working with radio stations across the country to develop a paging system that would exploit unused parts of the station's radio frequency to deliver messages.

THE TOP 5 PAGING SERVICES



Metromedia Paging
(owned by
Southwestern Bell)
500 Plaza Dr.
Secaucus, NJ 0709
(201) 330-3930

**Mobile Communications
Corporation of America**
1720 Capitol Towers
Building
Jackson, MS 39201
(601) 969-1200

PacTel Paging
12221 Merit Dr.
Dallas, TX 75251
(214) 991-9501

Graphic Scanning
329 Alfred Ave.
Teaneck, NJ 07666
(201) 837-5100

Paging Network
4965 Preston Park
Boulevard
Plano, TX 75075
(214) 985-4100

plications for alpha paging, market growth has been relatively slow. Until potential users recognize that the devices do not work the way traditional pagers do, few will be convinced that alpha pagers are worth the extra expense. Worse, many paging companies do not realize they are dealing with a totally different market, and have become disillusioned with the slow growth in alpha pagers.

But as understanding grows, alpha pagers will find acceptance tapping databases and acting as mobile message systems for both executives and technicians. Executives can't be bothered calling back; they need information they can use immediately. Technicians need an easy, flexible way to get detailed information in the field. Only alphanumeric paging can provide that information at a reasonable price. ■

Alan A. Reiter is a journalist who specializes in mobile telecommunications.

SOURCE: TELocator NETWORK OF AMERICA/HIGH TECHNOLOGY BUSINESS RESEARCH

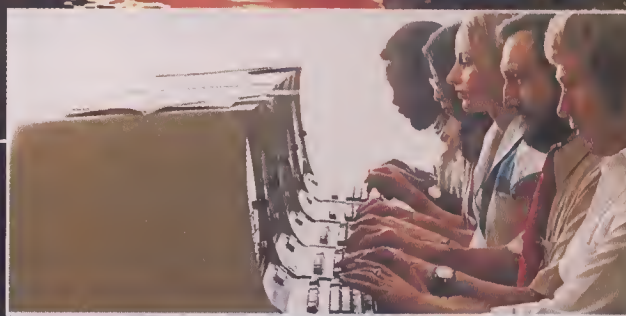
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COMTEX

Scientific Corporation

Companies Profit From Sounds of Silence

*Active noise-control technology promises to quiet
an increasingly noisy world*

BY FRANCESCA LUNZER

WHEN PILOTS Dick Rutan and Jeana Yeager flew the Voyager nonstop around the world in 1986, they had to scrimp on space, food, and sleep, but not on quiet. The two wore communications headsets that generated mirror-image sound waves to cancel out the roaring noise of the Voyager's engine. The result? "A more bearable cockpit," says Rutan.

At least five companies are working on devices that use this technology, called active noise control, to silence low-frequency noises that range from the rumble of an engine to the intense vibration of industrial fans.

Basically, active noise control uses a microphone to sample the sound waves of the offending noise. A computer processes this information and creates a signal that is the exact opposite of the noise signal. A speaker broadcasts this mirror-image sound wave, and when the two waves meet they cancel each other out, producing silence. Such systems work best against low-fre-

quency noise that occurs in a repetitive pattern, but research continues on systems that can quiet any sound or vibration. At its best, active noise control reduces unwanted din while letting people hear desirable sounds such as conversation.

Active noise control represents a dramatic step beyond passive attempts to deal with noise. The \$300-million passive-noise-control industry aims to muf-

fle sound with padding made from materials such as fiberglass and acoustic foam. Although padding works well against high-frequency noise, it is less effective against the low-frequency drone produced by air conditioners and power-station transformers. Also, padding can decrease performance and add weight to cars or airplanes.

The developers of active noise control think their solution to this age-old problem could bring in more than \$100 million by the early 1990s, though total sales were less than \$1 million last year. Several small specialty companies have been formed to explore the potential of active noise control, and larger corporations are also considering the technology for use in their own businesses. For example, acoustics engineers at General Motors and Boeing are conducting research on using active noise control to quiet vehicles and aircraft.

In the long run, reducing industrial noise will probably be the most lucrative market for active noise-control systems. That market divides into vibra-



Dick Rutan wore an active noise-control communications headset from Bose on Voyager's nonstop flight around the world.

FIGHTING NOISE WITH NOISE

Active noise control was first demonstrated in the laboratory in the 1930s, but it took modern computing power to provide the precision necessary to make the concept feasible.

The process takes advantage of the fact that all sounds consist of vibrating air molecules, and these vibrations take the form of relatively orderly waves composed of clearly defined peaks and troughs. Active noise-cancellation systems produce a mirror image of the noise sound wave, matching the peaks with troughs and the troughs with peaks. When the waves are added together the peaks cancel the troughs and vice versa, eliminating the noise.

A typical system has three basic components: a microphone to pick up the noise or vibration and send the signal to the computer, a controller to process the noise signal and create the antinoise signal, and a speaker or other transducer to project the antinoise signal.

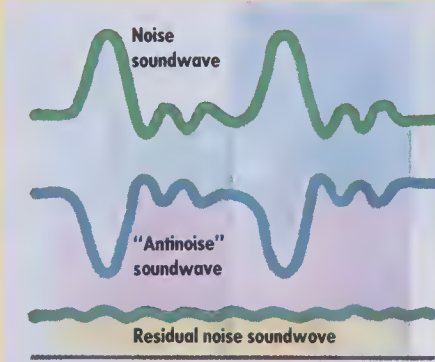
The microphone detects the noise and sends information about the sound wave to the controller, usually a computer, which creates a model of the wave and generates an antinoise signal with the exact opposite pattern. When the speaker broadcasts

the antinoise wave, the two waves cancel each other out, producing silence.

But to completely cancel a sound wave, the anti-wave has to mirror the noise wave perfectly and has to be exactly 180 degrees out of phase with the original sound so that its peaks hit the original wave's troughs. If the two waves don't dovetail precisely, the system will produce *more* noise, not less.

Theoretically, active noise control can deal with any sound, but today's technology is most effective on low-frequency noises, below 600 hertz. Fortunately, these are the noises that confound passive systems such as padding with acoustic foam and fiberglass.

Conversely, active noise-control systems have problems with high-frequency sounds, because the peaks and troughs of a high-pitched sound occur much more quickly. For example, a system from Digisonix samples sounds about 1,000 times per second—not nearly fast enough to handle high-frequency sounds that may vibrate 20,000 times per second. As the technology improves, newer active noise-control systems will be able to cancel high-frequency sounds more effectively.



tion control, designed to reduce defects in goods such as photographic film, and industrial noise reduction, according to researcher William Lederer, president of Minotaur Capital Management.

But so far, only about 20 industrial units have been sold, at about \$10,000 each. Most businesses seem to be waiting to see exactly what the industrial silencers can do and how much money they can save before committing to the new technology. "Plant managers and engineers are very interested," says Lederer, "but the people in the noise-control industry have to educate end users about how the technology fits in."

As the industrial market slowly ramps up, active noise control should enjoy its first success supplying communications headsets for pilots. Three companies—two British and one American—expect to introduce headsets in the United States later this year. Racal Acoustics Ltd. has already begun selling its headsets to foreign military buyers. Bose Corp. and Helmets Limited expect to begin selling headsets later this year. All three companies say active noise-control headsets that include communications capabilities will cost between \$500 and

\$600, about \$150 more than conventional communications headsets.

Bose, which made the headsets worn by Rutan and Yeager aboard Voyager, was founded in 1964 and is well known for its high-fidelity stereo speakers. Bose has been working on noise-control technology since the late 1970s.

"Bose presented a proposal to the Air Force in the early 1980s, just when the Air Force was looking to either develop it themselves or find a contractor," recalls Richard McKinley, a biomedical engineer at the Wright Patterson Air Force Base's Armstrong Aerospace Medical Research Laboratories near Dayton, Ohio. The U.S. Air Force requires hearing-protection equipment in aircraft that produce more than 84 decibels—slightly louder than a busy street corner. The noise level in a typical fighter can reach 105 decibels.

Bose headsets use a microphone to monitor the noise level inside the earcup. The headsets compare outside noise with the sounds wearers indicate they want to hear—radio communications, for example. The headsets then

create mirror images of the difference, cancelling out the unwanted noise. This cancellation, effective from 30 hertz (low C on a pipe organ) to 1,000 hertz (a tea-kettle whistle), reduces noise by 10 to 18 decibels, which Bose project-manager Dan Gauger says represents a reduction of about 50 to 80 percent of perceived noise in the cockpit.

The military should be an important market for active noise control, because military planes tend to be louder than commercial airliners. Also, military pilots generally sit just above the engines, which makes the cockpit even noisier. Padding the plane could help, but military designers don't like the added weight. Padding the pilot's helmet also adds weight—10 to 15 pounds, according to McKinley. The Bose headset weighs just over a pound.

The commercial market may be a harder sell. According to Bose's Gauger, commercial pilots show interest in the technology, but the Federal Aviation Administration requires malfunction alarms to send warnings through cockpit speakers, not headsets. "That makes commercial pilots wary about wearing anything that might keep them from hearing

the warning noises," says Gauger.

Bose isn't counting on aviation as the sole market for its headsets, even though initial sales will focus on pilots. Bose hopes to eventually sell more than half of its headphones to other workers in noise-filled environments, including industrial plants. Because headsets for these applications would not need communications capabilities, they would cost about \$400 each.

Headsets will come first, but several companies have made progress toward using active noise control in environmental systems. Nelson Industries of Stoughton, Wis., began marketing its digital sound-cancellation systems last June and formed its Digisonix division in September. The Digisonix system is designed to cancel low-frequency noise from industrial fans or central heating and air-conditioning equipment before it escapes through pipes or ducts. The system quiets sounds from 20 to 400 hertz and cuts sound levels at the source from 135 decibels to about 100 decibels, similar to the level heard when riding a subway train.

Digisonix places a microphone in a duct or pipe to sense the noise, and a speaker farther along the pipe emits the antinoise signal to cancel the noise before it can get out.

The price range is \$4,000 to \$40,000, depending on the size of the area to be quieted. According to Digisonix general manager Arthur Hallstrom, the division has installed 11 systems at an average cost of \$7,000 to \$10,000.

One \$6,500 system went into an industrial exhaust fan at Plastic Engineering Co. in Sheboygan, Wis., to quiet vibrations disturbing the plant's neighbors. "We retrofitted the exhaust stacks with the Digisonix system," explains Hallstrom, "and removed the objectionable tones from the air stream." The alternative—installing passive systems—would have involved more expensive modifications.

Digisonix plans to concentrate on similar installations for the foreseeable future. "There are tens of thousands of industrial fans out there, used for dust collection and ventilation," says Larry Erickson, vice president of research at Nelson Industries.

Digisonix competitor Noise Cancellation Technologies, in business since 1985, has garnered \$300,000 to \$400,000 from installations and prototype systems that control exhaust-system noise and industrial vibration. Noise Cancell-



ROB KINMONTH

Noise Cancellation Technologies wants to replace car mufflers, says vice chairman Harris Landgarten.

tion Technologies uses a two-microphone system to provide an extra level of silencing for residual noise. The company's NCT 2000 works best at cancelling low-frequency, repetitive noise made by such equipment as diesel and gas engines and factory machinery. Today, Noise Cancellation Technologies sells eight sizes of the NCT 2000 that cost \$15,000 to \$24,000.

One large industrial installation involved a \$25,000 vibration-control system for a major manufacturer of photographic film. "The film was vibrating coming off the rollers, causing an inconsistent coating on the film and requiring them to scrap 15 percent of the product," says Michael Parella, a director at Noise Cancellation. "We installed the technology inside the filmmaking equipment and antivibrated the film as

it came off the rollers. Virtually all the product came off the line with the exact layer of coating necessary." He says the system paid for itself in 90 days by reducing the company's product loss from vibration to less than 1 percent.

Other major markets for Noise Cancellation Technologies include quieting the several thousand small power plants in the United States (with \$10,000 to \$20,000 systems) and helping some of the country's 7,000 to 8,000 engine-test facilities muffle engine noise to soothe exasperated neighbors. Noise-control systems for engine test beds would cost \$15,000 to \$30,000.

Noise Cancellation is also working on automotive mufflers. Initially, the technology will help conventional mufflers

WHO'S WHO IN ACTIVE NOISE CONTROL

| COMPANY | PRODUCT | 1988 NOISE-CONTROL SALES (EST.) |
|--|-----------------------|------------------------------------|
| Base The Mountain Framingham, MA 01701 (617) 879-7330 | Headsets | Plans to start sales this year |
| Digisonix Box 428 Sloughtan, WI 53589 (608) 873-1500 | Industrial systems | \$1 million |
| Headsets Limited Wheat Hampstead Hartfordshire, England 283-4211 | Headsets | Plans to start sales this year |
| Noise Cancellation Technologies 98 Cutter Mill Rd. Great Neck, NY 11021 (516) 466-1060 | Industrial systems | \$4 million |
| Racal Acoustics Beresford Ave., Wembley Middlesex, England, HAO 1RU 903-1444 | Headsets | Not available |

SOURCE: HIGH TECHNOLOGY BUSINESS RESEARCH

cut low-frequency noise. As the technology gets better at eliminating high-frequency sounds, vice chairman Harris Landgarten predicts that it could eliminate conventional mufflers.

The company is developing prototypes to replace conventional mufflers for both a car maker and a muffler manufacturer. Landgarten says Noise Cancellation Technologies will have an active noise-control muffler ready for passenger cars by 1991 or 1992—even earlier for high-performance models. With mass production, he predicts the cost could drop to about \$100 each—still about \$60 more than current mufflers. However, Landgarten claims the new mufflers would restore power robbed by mechanical mufflers.

In the military market, Noise Cancellation Technologies has developed test systems for reducing submarine vibrations. Quiet submarines are harder to detect, and surface ships and helicopters could also use the equipment. Landgarten puts the potential military market for active noise control in the billions of dollars, and hopes to get a third of his company's business from the armed forces.

Analyst Lederer, however, is skeptical of the military market. "Given the slowness of the budgeting process, it's unlikely that we'll see a lot of dollars being spent on the technology in the next

few years," he warns. Even so, Landgarten expects Noise Cancellation Technologies to accumulate \$4 million in sales this year. The key to that goal is "real working examples of the technology in the field that prove themselves," he says.

As active noise control matures, the biggest threat to the specialty companies that now dominate the market may come from some of their potential customers. Most large industrial companies with noise problems are tracking the technology, and a few are actively developing systems on their own.

General Motors, for example, began research on active noise control in 1983 as part of an ongoing program to reduce interior vehicle noise. Passive technologies such as adding acoustic foam and shredded cloth to the upholstery adds unwanted weight to the car. GM researchers say current active noise-control technology works best on diesel engines, which emit lower frequency noises that are easier to cancel.

GM has installed a test system designed to cut noise levels in half in medium-duty trucks. High costs mean GM is still several years away from introducing the technology into its diesel fleet, but the company hopes to keep costs down by tying the noise-control system into the entertainment system.

Power companies are also working on their own systems. Power-station transformers use circulated air for cooling, but the vibrating air can produce as much as 140 decibels, well beyond the pain threshold.

After receiving complaints from power-station neighbors all over the country, Niagara Mohawk Power Corp. of Syracuse, N.Y., hired acoustic consultants who worked with the Electrical Power Research Institute of Palo Alto, Calif. (the research arm of the utility industry) to design an experimental active noise-control system for a power substation near Buffalo, N.Y., in 1983. The company installed microphones and speakers as well as a controller to process and transmit the antinoise signal. The experiment cost about \$400,000; a routine installation would cost about half that.

The Electrical Power Research Institute is developing a system it hopes to sell to power-station operators. Selwyn Wright, the institute's active-noise-cancellation project manager, says the system could cost several hundred thousand dollars, but he adds that utilities have spent at least that much in unsuccessful attempts at passive noise control. "Because the structures around power stations can't cancel out low-frequency noises," he says, "[active noise control] isn't an alternative solution—in some cases it's the only solution."

Active noise control is also attracting attention in the aviation industry. Several airplane manufacturers are working on propfan planes, to be powered by propeller-like devices called propellers. Propfan planes are more fuel-efficient than today's jets, but generate more noise inside the cabin.

Both Boeing Aircraft Co. and McDonnell Douglas' Douglas Aircraft Co. are looking into active noise control to reduce cabin noise in propfan planes, which are scheduled to reach commercial service in the early 1990s.

"Because air passengers have come to expect a fairly quiet cabin, it's been necessary to create innovative ways to control cabin noise," says Myles Simpson, who is responsible for interior-noise research at Douglas Aircraft. He says Douglas will initially use padding to reduce cabin noise, but has recently begun researching active noise control as well. The company plans to build a test system that would place microphones and speakers in the cabin to cancel noise. "If the technology proves feasible," says Simpson, "it could be introduced on a later-model propfan plane in the mid-1990s."

Active noise control appears to have a bright future in current applications, and new uses keep popping up as more companies learn about the technology. Bose marketing manager Harry Bloom says his company has received inquiries from textile manufacturers and coal-mining companies about the technology. But he doesn't think anyone should have to wait. Bose is considering marketing an active noise-control headset for consumers, for about \$450, that would cancel out low-frequency noise in any environment but let wearers hold conversations and hear other sounds. "This," says Bloom, "is an amenity consumers will want to have." ■

OPERATION TIME/MAIL TESTING/
 CASS:CODING ACCURACY
 SUPPORT SYSTEM/CRIS:
 CARRIER ROUTE INFORMATION
 SYSTEM/AIS:ADDRESS
 INFORMATION SYSTEM/NCOA:
 NATIONAL CHANGE OF ADDRESS/
 OCR READABILITY/BCS:BAR
 CODE SORTER/ZIP + 4/
 PRE-BARCODING/OPERATION MAIL/
 CASS:CODING ACCURACY
 SUPPORT SYSTEM/ZIP + 4
 DISKETTE SERVICE/
 MANIFESTING/PRE-BARCODING/
 ZIP + 4/AIS:ADDRESS
 INFORMATION SYSTEM/NCOA:
 NATIONAL CHANGE OF ADDRESS/
 OCR READABILITY/BCS:BAR
 CODE SORTER/ZIP + 4 NATIONAL
 FILE DIRECTORY/OPERATION
 MAIL/PRE-BARCODING/
 AIS:ADDRESS INFORMATION
 SYSTEM/CRIS:CARRIER
 ROUTE INFORMATION SYSTEM/
 ZIP + 4 DISKETTE SERVICE/
 NCOA:NATIONAL CHANGE OF
 ADDRESS/OCR READABILITY/
 BCS:BAR CODE SORTER/
 ZIP + 4 NATIONAL FILE
 DIRECTORY/OPERATION MAIL/
 CASS:CODING ACCURACY
 SUPPORT SYSTEM/ZIP + 4/
 CRIS:CARRIER ROUTE
 INFORMATION SYSTEM/AIS:
 ADDRESSING INFORMATION
 SYSTEM/ZIP + 4 DISKETTE

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Designware Leader Faces New Threat

Technology advances have intensified the struggle to dominate the market for computer-aided software engineering

BY SUE ANN HAWLEY

A HORDE OF companies, from banks to manufacturers to retailers, invest millions of hours and billions of dollars each year in writing and maintaining their own specialized mainframe-computer programs. These software-development tasks have become such a headache that corporations are clamoring for any technology to make such tasks easier and cheaper.

That's why CASE—computer-aided software engineering—has become the buzzword in software. Generally, CASE describes a new concept in developing software that relies on automation (the “computer-aided” part) and on standardized, repeatable methods (the “software engineering” part). It's software for designing software.

In the last five years, such “designware” tools have become as numerous as official products of the U.S. Olympic Team, and the number of CASE suppliers has grown from one to more than 60. Yet despite its popularity, computer-aided software engineering is not bringing high revenues or even profits to most of the companies selling it.

But at least one supplier, Index Technology, is making a fortune. By special-

izing in software that helps programmers during the critical initial-design phase, Index has grown into a \$21-million company in its first three years, making it the market leader in computer-aided software engineering.

Now, however, Index is being challenged by a couple of promising upstarts: Knowledgeware and Texas Instruments. These two companies are peddling something new in the CASE arena. Instead of stopping at program design, their systems turn the design into a working computer program. They call it the integrated solution—using software to combine the conceptual planning steps of program development with the next stage, writing the computer code.

Add a fourth company, Nastec, which essentially founded the CASE industry six years ago, and you have a four-way battle for leadership of a market that by some estimates could total \$1 billion by 1990.

It's a classic confrontation of the old guard against the enthusiastic new recruits. Both Index Technology and, to a lesser extent, Nastec, have built successful businesses with their CASE products for software design. Now

along come Knowledgeware and TI, with integrated systems.

These suppliers are vying for the business of the 15,000 corporate data-processing departments using IBM or compatible mainframes. Each department is typically responsible for meeting the information needs of a major division or the entire corporation. To do this, they create and run management-information systems, dubbed MIS in business-management jargon. Typically, an MIS program is a labyrinthine piece of specialized software designed to collect information, organize it, and distribute it to managers who need the data to make the company run.

Unfortunately, developing these programs has never been easy. Despite its image as a modern science, in practice corporate computer programming often looks more like black magic. Computer-aided software engineering is an attempt to remedy problems by using computers to organize and automate the stages of software development. It's a relatively new approach that has not yet caught on. A recent study by Focus Research estimates that CASE programming tools are installed in only about 4 percent of IBM-mainframe and

THE TOP CASE CONTENDERS

| COMPANY | 1986 REVENUE | 1987 REVENUE | PROJECTED GROWTH | PROSPECTS |
|---|----------------|--------------|-----------------------|--|
| Index Technology 1 Main St. Cambridge, MA 02142 (617) 494-8200 | \$15.2 million | \$21 million | 50 percent in 1988 | Has a 52 percent market share. Will probably maintain leadership in design-stage CASE components, but could fall behind Knowledgeware and Texas Instruments if the integrated market heats up. |



Index vice president Chris Grejtak contemplates strategies to ward off up-and-coming competitors.

compatible corporate programming departments. Industry consensus estimates the CASE market will expand by 50 percent this year, and could reach \$1 billion by 1990. Even at that level, there may still be tremendous potential for future sales.

But so far, aside from leaders such as Index, CASE sales have been discouraging. The sudden abundance of CASE tools has bred confusion among both customers and suppliers, and many potential customers remain skeptical.

Still, reports by some CASE pioneers are encouraging. Barbara Bouldin, staff manager for Network Operations at AT&T's operation in Parsippany, N.J., was so successful that other AT&T units now come to her for help in getting started with CASE. "The combination of Excelerator [Index's CASE product] and some in-house techniques has

fundamentally changed the way we develop systems," she says.

As such advantages become more apparent, "CASE-type products will be the standard instead of the domain of just the early adopters," says Chris Grejtak, Index Technology's vice president of sales and marketing. The question is, what type of products will they be?

To date, CASE suppliers have concentrated on tools that handle only one aspect of program development. Some companies, including Index and Nastec, stick with products that help programmers design software; others sell tools for writing programs, and still others concentrate on program-maintenance products. The integrated-solution sellers, Knowledgeware and Texas Instruments, roll design and code writing into one. "You are either a components vendor or an integrated-CASE vendor,"

asserts Mike Watters, Texas Instruments' manager of advanced information systems. The battle lines are drawn.

So far, Index Technology has the most to lose. Though founded only in 1984, its products account for about 52 percent of the CASE market, according to industry consultant Focus Research. The company's meteoric rise reads like a fairy-tale account of how a successful startup should perform. It was profitable in its first year. In its second, revenue increased five fold, to more than \$10 million. Index has grown by about 50 percent each year since, with 1987 revenues of about \$21 million.

Obviously, the company has done something right. One good move was to ride the wave of IBM PC mania with its Excelerator product, which did not require customers to buy additional hardware. Index also took pains to make Excelerator easy to use—a popular feature in any program—and stuck to a simplified approach to software engineering.

This approach focused on a few tasks that every program designer must tackle, such as drawing diagrams to plan a program and documenting design information.

Further, Index emphasized Excelerator's simplicity by straightforward marketing that is widely credited with attracting customers to a product they may not otherwise have understood. Today, the company is deeply entrenched. "Index is viewed as having a strong sales and marketing organization," says vice president Grejtak.

But nipping at its heels is Knowledgeware. Knowledgeware became a CASE player in 1985, but the action didn't start until its 1986 merger with Tarkenton Software. The union gives the company both the design-phase tools of the old Knowledgeware and the program-writing expertise of Tarken-

WILLIAM HUBER

THE TOP CASE CONTENDERS

| COMPANY | 1986 REVENUE | 1987 REVENUE | PROJECTED GROWTH | PROSPECTS |
|---|---------------|--------------|----------------------------|---|
| Knowledgeware 3340 Peachtree Rd. N.E. Atlanta, GA 30326 (404) 231-8575 | Not available | \$11 million | 100-200 percent in 1988 | Has generated much interest with its integrated tools; recent boosts in revenue indicate a growing customer base. However, the company must stave off inroads from heavyweight Texas Instruments. |

ton. The company's product, called the Information Engineering Workbench, addresses several phases of the software-development process, including program writing, says executive vice president Don Addington. The privately held company claims to have turned profitable last year, with revenues of about \$11 million.

"The reception to our new products has been phenomenal," says chairman and chief executive Fran Tarkenton. He says new products and an aggressive marketing program this year should more than double last year's revenue—which would push Knowledgeware beyond Index's 1987 benchmark.

However, rumors questioning Knowledgeware's viability float continually. So far, the company has apparently failed to capture an impressive market share; it barely makes it into market-share studies by such analysts as Focus Research. But in fairness, Knowledgeware is a relative newcomer.

"We took some time to get organized after the merger," says quarterback-turned-entrepreneur Tarkenton. Now the company has some impressive strengths in its favor. These include a powerful alliance with the Big Eight accounting firm Arthur Young, which also does consulting work in software development for large clients—just the thing for peddling CASE tools.

The company's greatest strength, if it is to become the dominant CASE supplier, will have to be its integrated approach to software engineering. But Knowledgeware will have to work harder to sell that approach now that heavyweight Texas Instruments is entering the same segment. Last year, TI introduced its Information Engineering Facility, a commercial version of CASE tools it originally developed for its own programmers. Like Knowledgeware's product, TI's entry takes corporate program writers through both the design and writing processes.

Surprisingly, both Knowledgeware and the rest of the CASE community



Georgia Ley of Sun Exploration was sold on TI's stability.

show casual indifference to Texas Instruments, citing TI's past market failures such as home computers. But Suzie Starnes, a TI marketing analyst, says, "TI has deep pockets and is in this market for the long run. Up to this point, our efforts have been on product development. Now we are ready to aggressively market the product."

Georgia Ley, manager of information-system development for Sun Exploration & Production Company in Dallas, has been using CASE tools from Texas Instruments for more than two years, starting as a test site. One of the factors that attracted her to Texas Instruments was the staying power of a large company with the resources and commitment to support its products over the long haul. "We believe Texas Instruments has the best ability to listen to our needs and respond," she says.

With testimonials like that, TI hopes to meet its ambitious revenue goal of \$12 million to \$15 million in 1988, its first full year in the CASE market.

A force still to be reckoned with is six-year-old Nastec, the oldest CASE supplier, which has not fared as well as some of its younger competitors. Nastec's blunders date back to the company's beginning, when it built its DesignAid software to run on relatively obscure workstations from Convergent Technologies of San Jose, Calif. Since then, Nastec has followed the example of Index, reworking its software to run on ubiquitous IBM personal computers and compatible machines.

But the company's problems went beyond its choice of hardware. Just when it seemed to be getting ready to expand its design-stage CASE tools into program writing (possibly through a merger with Tarkenton Software), Nastec was tripped up by a management overhaul when it failed to please investors by meeting revenue targets. The still nascent CASE market swung strongly toward Index while Nastec's 13 venture-capital investors dismantled the executive

management in 1986—"living proof of the inner turmoil that venture capital provides," says Arthur Young director Al Hershey. A new president was in place by October 1986, but Nastec had already lost considerable ground.

Nevertheless, the company retains some strengths, particularly its current market position. According to Scott Brown, marketing research manager at Focus Research, Nastec owns about 11 percent of the CASE market, a weak second in the industry behind Index.

Nastec is aiming for 50 percent sales growth this year, largely by expanding into new markets. The company has traditionally been a strong seller to MIS departments—by far the largest computing segment in corporate America, and the market most sought after by mainstream CASE suppliers. "Nastec plans to hold that base while expanding into the engineering/scientific market," says Paul Radding, the company's vice president of marketing.

To do so, Nastec must clear two for-

THE TOP CASE CONTENDERS

| COMPANY | 1986 REVENUE | 1987 REVENUE | PROJECTED GROWTH | PROSPECTS |
|---|---|-----------------------------|-----------------------|--|
| Nastec 24681 Northwestern Hwy. Southfield, MI 48075 (313) 353-3300 | \$8 million (estimate; does not release figures) | \$10-\$14 million (est.) | 50 percent in 1988 | Holds about 11 percent of the market. Aims at both business and scientific/engineering markets and may shine in one if it recovers momentum lost during a management shuffle; unlikely to be powerful in both. |

CONFUSION OVER CASE

If the success of the CASE business were measured by the popularity of the acronym, the market would be booming. But at present, the short form of "computer-aided software engineering" is more famous than the products it represents.

The term has fallen prey to marketers who attach it indiscriminately to all sorts of products to lure customers. Consequently, many people who could benefit from CASE are confused about what it is.

CASE essentially describes a way to create software that relies on automation and standardized methods. This sounds simple enough, but it represents a considerable departure from traditional dependence on pencils, scratch pads, and the quirks of individual programmers.

CASE suppliers divide software development into four segments: planning, program design (the part before actual writing begins), code generation (in which programmers translate the design into computer-language statements), and the production phase, when the program is put to work and must be maintained.

Until the recent introduction of systems that handle both design and code writing, CASE suppliers concentrated on one segment. For example, some companies provide

software that helps data-processing departments determine the needs of the people who will use the program. Other companies make tools that help writers test completed programs. Still others specialize in code writing, and may focus on a specific computer language such as Fortran or Cobol.

CASE suppliers split further over the methods their systems use. Data-processing departments follow different techniques or procedures. Hence, some CASE suppliers specialize in niches built around particular methodologies.

Most CASE products work best when they are used to develop new computer programs; they don't mix well with preexisting systems. But the biggest problem facing data-processing departments is the maintenance of existing programs, which consumes well over half the resources of a typical department. CASE advocates argue that better planning, design, and documentation will yield higher-quality programs that need less maintenance. That makes sense, but most data-processing departments are so burdened with upkeep—backed up for three to seven years before they can even start a new program—that they may have trouble finding the time to try computer-aided software engineering.

midable hurdles. First, it faces another strong competitor, Cadre Technologies of Providence, R.I., which is the established leader of the engineering segment. Second, Nastec must tailor its products for uses that are very different from the tasks done by MIS software, the kind it knows best.

A recent report by the Gartner Group questions Nastec's strategy. "We do not believe Nastec can successfully straddle diverse CASE markets," the report reads. "We believe its best fit is with aerospace/defense/engineering. It should rapidly build or acquire appropriate technology to offer more comprehensive facilities for those users."

A compelling reason to concentrate on the engineering and scientific segment, aside from MIS inroads by Knowledgeware and Texas Instruments, may be the aggressive plans of archival Index. Like Nastec, Index expects 50 percent growth in revenues this year.

"After a heady couple of years, Index took a serious look at its strengths and

weaknesses," says marketing manager Grejtak. "We built an infrastructure to support our fast growth. That means expanded distribution," through more than 60 programming consultants who take on software-development jobs for many corporations.

Most significant, however, are Index's plans to create more strategic alliances with CASE companies that supply software for generating computer code. Such alliances provide easy links between Excelerator and program-writing tools. Index currently has agreements with the larger code-writing suppliers, including segment leader Pansophic Systems of Oak Brook, Ill., maker of Telon software. Index says it's more efficient to form such links than to develop its own program-writing systems.

To the uninitiated, this approach may seem old-fashioned; wouldn't a program developer rather use a single, integrated set of tools from start to finish? But such a system locks a program

writer into the CASE supplier's particular method of software development. Some companies want to use their own methods, so they often pick and choose among CASE suppliers to assemble systems that best suit their needs.

Even Georgia Ley of Sun, a devotee of Texas Instruments, is noncommittal about using TI's code generator once it becomes available. Her hesitation may be another sign of the general uncertainty over CASE. Customers and potential customers have heard too many promises. Now they're waiting to see more evidence before leaping headlong into one of the competing CASE approaches. Their uncertainty will continue to annoy the growing list of CASE contenders. Still, the potential market remains alluring enough to keep such companies in the fight. ■

Sue Ann Hawley, based in West Bloomfield, Mich., is a journalist and marketing-communications consultant for the software industry.

THE TOP CASE CONTENDERS

| COMPANY | 1986 REVENUE | 1987 REVENUE | PROJECTED GROWTH | PROSPECTS |
|---|---------------|---------------|---|--|
| Texas Instruments 6550 Chase Oaks Blvd. Plano, TX 75086 (214) 575-4404 | Not in market | Not available | 200-300 percent; \$12-\$15 million in 1988 revenues | Customers are waiting to see some announced products. If products fulfill expectations, they could push TI to the fore, particularly in the integrated market. Customers attracted by TI's size and stability. |

Lockheed Chairman Lawrence Kitchen

ON DEFENSE CONTRACTING

MANY OF THE MOST advanced technological innovations come from the defense industry, where government sponsorship puts large research-and-development funds in the hands of suppliers. But those funds come attached to strings that entangle the industry in issues and practices that do not encumber commercial businesses.

Lockheed is one of the largest defense companies. Its \$10 billion in annual sales—90 percent of it to the government—places it among the largest suppliers in the segment. Since January 1986, the Calabasas, Calif., company has been under the guidance of chairman and chief executive Lawrence O. Kitchen. Before that, he was president and chief operating officer for a decade.

To find out how the defense industry is standing up under the new budget-cutting pressures in Washington, we sent assistant managing editor Jeffrey Zygmunt to the office of Lockheed's chairman.

■ *HT Business: What is the most pressing issue in the defense business?*

KITCHEN: The industry is in a downturn, any way you look at it. Appropriations are down in the fiscal 1988 budget, and they will be in the fiscal 1989 budget, in order to beat the deficit.

You can debate whether that's the right place to reduce the deficit or not. Unfortunately, both the industry and

Lawrence Kitchen

Born: June 8, 1923

Joined Lockheed:

1958

Responsibilities:

Strategic and
operational
management

Revenue controlled:

\$10 billion/year

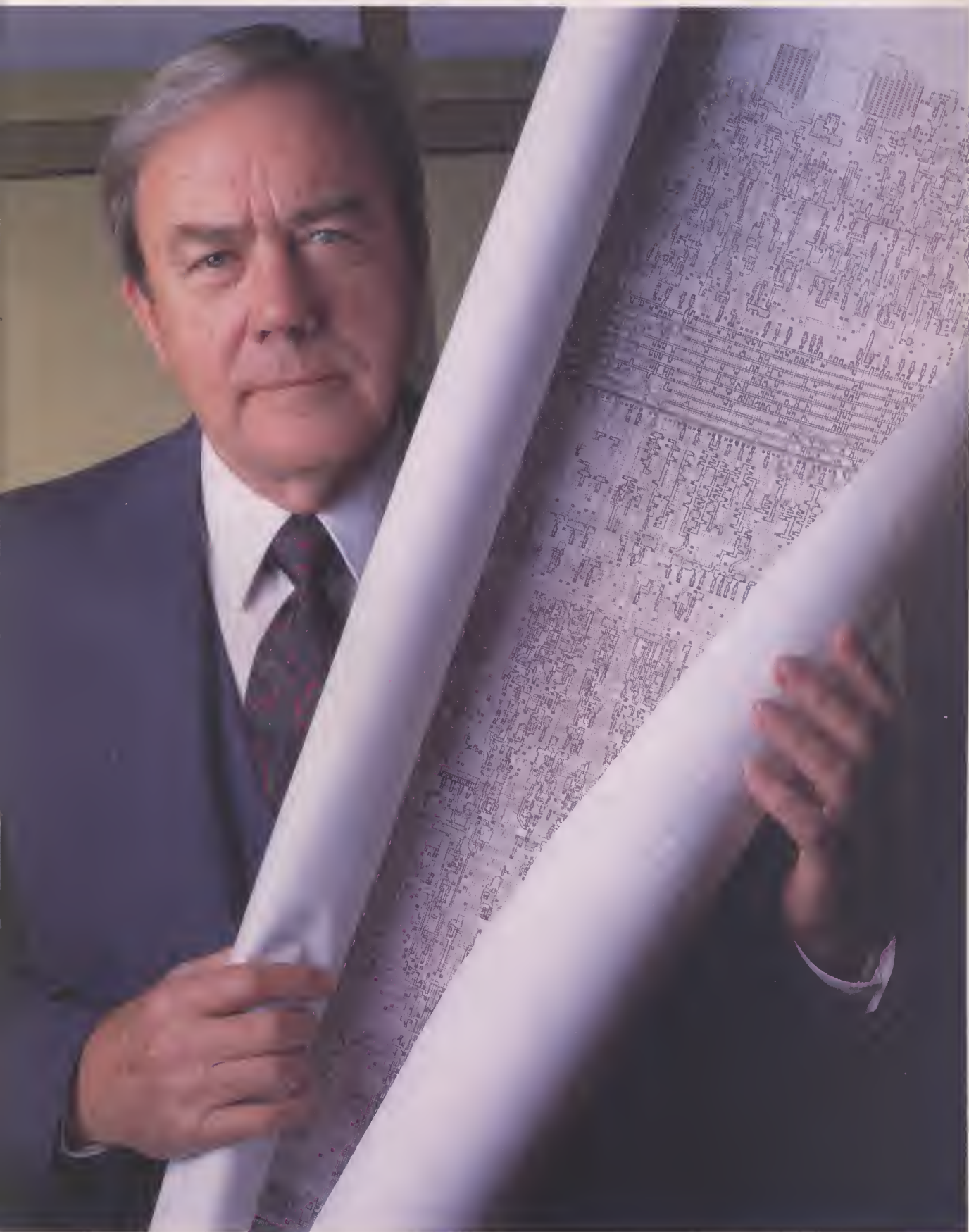
R&D budget:

More than \$3
billion (including
government
programs)

Employees:

97,000





MARK HANAUER

the Defense Department have lost part of the argument because of the horror stories about overpricing that have tarnished the industry. The public perception is one of inept management and spending that's not well controlled. True, there were a bunch of stupid things done. But the fact is, things were sometimes overpriced because of procedures within the government accounting system. Of course, you can't explain that to the person on the street, who says, "How can you pay \$600 for a toilet seat?" Well, I can show you how that can happen, but that doesn't make it right.

Defense would be lucky if it could break even, keep up with inflation, but I don't think that's going to happen. There's probably going to be a downhill budget environment, causing the Defense Department to make some very hard choices regarding where monies will go.

■ *HT Business: What will get cut?*

KITCHEN: Congress is saying, "Why don't you stop small production programs, because the quantities you're buying aren't economical." But Congress is losing sight of the fact that the monies aren't available to buy larger quantities. It's a tough proposition, but I'm sure the Department of Defense [DoD] will cut back on small production programs, because it will have to keep pouring in money to develop new systems to counter technology threats.

The next tough choice is, what is needed to counter those threats? Some people in Congress feel that programs that have already been started in the so-called Reagan buildup period represent a huge dowry of things that, if carried out, would be well over any realizable defense budget. So the question is, how many of the programs that have already been envisioned or started can the DoD carry to graduation in this legislative environment?

By and large, I think you will see longer development periods. That will drive costs up, but I think it's coming. You will also see a lowering of program requirements.

■ *HT Business: What effect will the new legislative environment have on your business?*

KITCHEN: The reform legislation of the past two or three years has done an awful lot to harm capital formation within this industry. On one hand, Congress and the DoD says, "You've got to be more competitive; invest, get productivity up, use new techniques to get costs down." On the other hand, they're driving capital formation down.

One problem is recovering our costs on independent research and development. Like companies in a commercial business, Lockheed recovers those costs in the price of our goods. Now the government is saying we shouldn't get all of it back; that you can recover only about 70 to 75 percent of what you spend on independent research and development. Any dollar we spend over that is another dollar off the bottom line. That gives you a choice to make. You might say, "Okay, that's all I'm going to spend." But you can't survive on that. So we spend what we think we need to spend to remain up on technology. That affects capital formation.

Another example: Government agencies are saying to the industry on R&D programs, "You must cost-share [pay a portion of development costs] if you want to participate." The industry is accepting that because it really doesn't have a choice. But when you do that, you take the money right off the bottom line, deteriorating capital formation.

Another issue is cost-sharing on big-ticket items that you

are competing for, such as the advanced tactical fighter. If there are two teams competing, you don't know if you'll win; it's a big crap shoot. That further deteriorates capital formation because you're spitting out dollars with no assurance of a return.

I'm not griping about it. If this were a perfect world, the government wouldn't ask us to cost-share on major R&D programs. But they do. So we're playing, and playing hard.

But I am very much concerned, and I think the industry and the DoD is also concerned, that contractors will start to make short-sighted decisions—that they will cut back on capital investments. Lockheed spends about \$450 million to \$500 million a year on capital investments. That's a lot of money. If a company is making a short-term decision, it would look at cutting back there. But that is something you should not do if you're looking at improving capability. I could make dumb decisions every day for the short term, and it would look great this year or next year, but it sure as hell wouldn't look good for the long term. However, if a company gets pushed to the point where its capital formation is down, it may not have any choice.

■

“A corporation cannot afford to nurse its capital by not spending on R&D.”

■

■ *HT Business: What do you see as the worst-case scenario?*

KITCHEN: I'm really concerned about what contractors are going to pump back in. In this kind of environment, will companies start making short-term decisions that are dumb?

It would be easy for me to say, "We're not going to spend, say, \$450 million in capital expenditures this year; we're going to spend \$300 million. That's it, guys; go figure out how to do it." But we're not making those kind of decisions. We're still investing. I'm worried that the industry may have a break point, and people may start making dumb decisions and not reinvesting in new technology. They may be forced to. I think the DoD is beginning to recognize that, and Congress has set up a committee to look at that problem.

■ *HT Business: But for the time being, you must squeeze out cost where you can, accepting the lower margins. Is there a better solution?*

KITCHEN: There are only a few ways to improve profit margins. You can negotiate higher profits, or you can cut down on disallowances—those things that government auditors don't allow you to charge for. You can also cut back on discretionary spending, such as equipment, and on independent research and development. That's about all you have at your discretion.

As for getting costs down, that's not something the industry turns on or off when things get tough. We do it all the time. But driving cost out doesn't necessarily mean you're going to improve your profit margins that much, because if we make improvements in our productivity, it gets taken into account when we negotiate our contract. You cannot negotiate at the same old price.

■ *HT Business: Despite cutbacks, defense electronics is expected to see high growth. What are you doing to assure you get a piece of that?*

KITCHEN: No one envisions Lockheed as an electronics contractor, because our financial statements don't show it. We do a lot of electronics, but it's in black [classified] programs. We decided that we really needed to have a nucleus around our good old electronics capability, so we bought Sanders Associates [a Nashua, N.H., defense-electronics company].

Defense electronics was growing at an astounding rate, and today 50 percent of the content of weapons systems that we sell is electronics. It's still a growth business, but probably less today because it will get cut along with other areas.

■ *HT Business: With these slowdowns in defense spending, is the industry getting more competitive?*

KITCHEN: Competition will be tougher because there will be fewer programs to go after. For example, there is only one new airplane program out there, the advanced tactical fighter. Everything else is gone.

Look at the space program. When we started out, things would be up in orbit for two and three months. Now, they're up there for years. The number of things we sell dwindles as the technology gets better, improving longevity. Therefore the market is much more competitive today than it was 10 years ago. The tough thing in this new environment is deciding where to invest to beat the competition.

But a corporation cannot afford to nurse its capital by not spending on R&D; if you do, the world will pass you by. All the defense contractors are saying, "What can we do to reduce cost; what can we do to be more competitive; what can we do to improve technology to be one up on the next guy?" Other companies are improving their electronics capabilities because they see the same thing we do. So the improvements I'm talking about are happening not just at Lockheed, but throughout the industry. It would be a disaster if Congress or the DoD were to tell us how to do it.

■ *HT Business: Is that a possibility?*

KITCHEN: That's always a possibility. In this kind of competitive environment, the government benefits by less restriction and control. The guys who are in the business and running the business day-to-day know more about how to get costs down than somebody on the outside. If you took out the controls and micro-management and all the things that go along with defense contracts, you could probably drive 20 to 30 percent of the cost out today.

■ *HT Business: What is the first government regulation you would change, if you could?*

KITCHEN: The government needs to get rid of some of their overseeing. I could go through a whole list of things: over-specification, over-management, micro-management, reviewing everything. They should say, "Here's what I want; meet the requirement or else you don't make money."

■ *HT Business: So the government is looking too closely over your shoulder?*

KITCHEN: Look what happened when we had all those horror stories about overpriced spare parts. The government's first reaction should have been to grab all the CEOs by the nape of the neck and say, "Hey guys, I'm not going to screw around with you. If your company is doing something wrong, knock it off." Instead, they hired umpteen auditors who are out there justifying their existence. The auditors write reports and walk away from them. We've had two and three audit agencies in here at the same time, doing the same thing. That was a knee-jerk reaction to a problem, rather than taking the appropriate action. That's what I mean by micro-management.

I wish the new secretary of defense, Frank Carlucci, was going to be there longer. He's good. He understands the business and worries about the business—not just about the macro issue of national defense. He worries about the industrial base, its capabilities, and so on. Unfortunately, he has less than a year left with this administration.

■ *HT Business: Team bidding on major programs such as the space station and the National Aerospace Plane is becoming more common. How do you reconcile team membership with competitiveness?*

KITCHEN: The defense industry is pretty much a family anyway, although we're highly competitive. We cut each other's throats—almost—on a big program. But it's not an underhanded, dog-eat-dog environment.

Because there are fewer programs, you may see more teamwork. The advanced tactical fighter was going to be a cost-sharing contract, but it was a lot to cost-share. It didn't make sense for seven or eight major aerospace contractors to butt heads and spend a whole lot of money, and no single contractor could lay claim to all the capabilities the project requires. So we started thinking about teamwork. That's a real advantage for the government and the nation, because the project is bringing together the capabilities of well-recognized contractors.

■ *HT Business: Are you considering diversifying, getting deeper into other businesses to deal with the worsening defense climate?*

KITCHEN: We think about diversification in many ways. Our information systems are a big part of that, because they are all commercial and have the potential to grow. But even if we were 10 percent commercial, we would be a \$10-billion corporation with a billion dollars in commercial business. Bottom line: It's not going to make that much difference.

It doesn't make any sense for Lockheed to go out and acquire a big commercial activity. We wouldn't know how to run it. Working in defense is very different from running a commercial business. When we do strategic planning, we look for things that we can spin off and do commercially, but I don't see us acquiring anything commercial.

■ *HT Business: So it's safe to assume that Lockheed is in the defense business for the long haul?*

KITCHEN: It's still a fun business sometimes. Today we're looking at all our strategic plans, our five-year and twelve-year plans. You have to look today at where you will be at the turn of the century. You have to start early. ■

GET THE EDGE

In case you missed any of these stories when they appeared in HIGH TECHNOLOGY BUSINESS, here is a selected listing from the past year. Check the stories you want and fill in the form. Include \$5 for each story to cover photocopying, postage, and handling.

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- ☐ Camcorder Companies Divvy Up a Bewildered Market
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- ☐ 1988's Hottest Superconducting Companies
- ☐ Alternate Fuels Edge Into Auto Markets
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- ☐ AIDS Crisis Spurs Hunt For New Tests
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- ☐ Competitors Team Up
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OFFICE PRODUCTS



K-4 page printer. Produces 24 pages/minute; prints on both sides of sheets as large as 8½×14 inches. In page mode, resolution is 300 dots/inch. The printer includes a Motorola 68000 processor. Less than \$19,000. Kentek Information Systems Inc., 6 Pearl Court, Allendale, NJ 07401. (201) 825-8500. *Circle 1.*

GammaFax MC PC-to-fax system. A communications package that allows IBM PS/2 users to send documents to any digital facsimile machine. The system sends any DOS file over ordinary telephone lines as quickly as 9,600 bits/second; it consists of a plug-in circuit board and software. \$995. GammaLink, 2452 Embarcadero Way, Palo Alto, CA 94303. (415) 856-7421. *Circle 2.*

ImageCard fax modem card. Equips IBM PC/XT/AT and compatible computers to communicate with Group 2 and Group 3 facsimile machines. The card lets the computer perform other functions while it sends or receives documents. Incoming messages are automatically saved on disk. \$1,175. Ricoh Corp., 5 Dedrick Place, West Caldwell, NJ 07006. (201) 882-2000. *Circle 3.*

IX-12F scanner. This flat-bed device captures text and graphics and sends them to an IBM PC/AT or compatible computer. The desktop unit provides a resolution of 300 dots/inch at a scanning speed of 16 seconds/page. \$1,495. Canon U.S.A. Inc., Systems Division, 1 Canon Plaza, Lake Success, NY 11042. (516) 488-6700. *Circle 4.*

LanCard A-II adapter card. Connects IBM PS/2 Models 50, 60, and 80 to Arcnet token-passing local-area networks. The card lets a diskless workstation load operating software from the hard disk of another computer on the network. Compatible with Novell Netware and other popular software. \$695. Tiara Computer Systems Inc.,

2700 Garcia Ave., Mountain View, CA 94043. (415) 965-1700. *Circle 5.*

Model 941/951 image systems. These two digital systems handle freeze-frame video images. Model 941 stores NTSC color or monochrome images with resolutions of 512×480 or 512×240 pixels. Model 951 combines an IBM PS/2 Model 30 computer with a Model 941 and an internal 9,600-bit/second modem to transmit as well as store images. From \$6,000 for Model 941; from \$10,500 for the 951. Colorado Video Inc., Box 928, Boulder, CO 80306. (303) 530-9580. *Circle 6.*

Multi-Font dot-matrix printers. Let users feed single sheets of paper without removing the tractor feeder. Model NX-1000 has several fonts for use with most personal computers; Model NX-1000C works with Commodore 64 and 128 computers. Both print 144 characters/second in draft mode, 36 characters/second in near-letter-quality mode. \$289. Star Micronics Inc., 200 Park Ave., Suite 3510, New York, NY 10166. (212) 986-6770. *Circle 7.*

Multistation network connector. A junction box that connects as many as eight personal computers in IBM Token Ring local-area networks. Users can mix these units with those from IBM in the same network. \$395. Racore Computer Products Inc., 170 Knowles Dr., Los Gatos, CA 95030. (800) 521-6366; in Calif., (800) 325-1833. *Circle 8.*

PCnet-2 network card. A local-area-network card for the Personal System/2 Models 50 and 60. The card works through a CATV-baseband cable and allows as much as 7,000 feet between network nodes. Provides data access at one million bits/second and works with other PCnet and PCnet/Conquest cards. \$495. Orchid Technology, 45365 Northport Loop West, Fremont, CA 94538. (415) 683-0300. *Circle 9.*

TurboScan optical scanner. Captures text and images from books and three-dimensional objects with a resolution of 300 dots/inch. Works with the Macintosh. The sheet-feed device accepts documents as large as 8½×14 inches and can scan line art and half tones. \$1,699. AST Research Inc., 2121 Alton Ave., Irvine, CA 92714. (714) 553-0340. *Circle 10.*

WordFinder thesaurus. This calculator-sized device contains 100,000 words and 220,000 synonyms. \$99.90. Selectronics, 701

Decatur Ave. North, Minneapolis, MN 55427. (612) 545-6823. *Circle 11.*

ZX-405 electronic typewriter. The typist can program this unit to automatically spell out abbreviated words. The machine types 18 characters/second and has a 39-character liquid-crystal display. \$629. Sharp Electronics Corp., Commercial Typewriter/Calculator Division, Sharp Plaza, Mahwah, NJ 07430. (201) 529-8885. *Circle 12.*

COMPUTER HARDWARE

PPC 640 portable computer. Weighs 11¾ lbs.; includes an 8086 eight-megahertz processor, a 9-inch-diagonal liquid-crystal display, one or two 3½-inch disk drives, and 640 kilobytes of random-access memory. The computer also has a 300/1,200/2,400-baud Hayes-compatible modem. \$999 for a single-drive model; \$1,099 for two drives. Amstrad Inc., 1915 Westridge Dr., Irving, TX 75038. (214) 518-0668. *Circle 13.*

286 Express accelerator card. Boosts the performance of Tandy's 1000 and 1000 SX personal computers, which are based on an 8088 processor, to that of an eight-megahertz, 80286-based machine. The half-slot card runs at 7.2 megahertz and has eight kilobytes of cache memory. Works with IBM PC/XT software and hardware. \$399.95. Tandy Corp., 1800 One Tandy Center, Fort Worth, TX 76102. (817) 390-3487. *Circle 14.*

Above Board 2 memory board. Provides as much as two megabytes of memory in one slot for IBM PS/2 Models 50 and 60. Compatible with the OS/2 operating system. Software utilities include random-access-memory disk support, which lets users handle very large programs or files, plus diagnostic routines and a print buffer. \$645 for a version with 512 kilobytes of memory. Intel Corp., M.S. C03-07, 5200 N.E. Elam Young Parkway, Hillsboro, OR 97124. (503) 629-7354. *Circle 15.*

AT 386/20 personal computer. This 20-megahertz machine uses an 80386 processor and has a 1.2-megabyte floppy-disk drive as well as one megabyte of random-access memory (expandable to four megabytes). It includes an IBM PC/AT-style keyboard, plus one serial and one parallel port. \$4,790.

Systems Integration Associates, 222 East Pearson Ave., Suite 502, Chicago, IL 60611. (312) 440-1275. *Circle 16.*

AT Zip memory card. Holds four megabytes of expanded memory for IBM PC/AT/XT and compatible computers; four cards can be installed in one computer. The card handles operating speeds of eight megahertz with no wait-states, 12 megahertz with one wait-state. Works with DOS, Unix, and Xenix operating systems. \$995. Micron Technology Inc., Systems Group, 2805 East Columbia Rd., Boise, ID 83706. (800) 642-7661. *Circle 17.*

Drive Plus 40/SS hard-disk card. This single-slot expansion card adds 40 megabytes of memory to the hard disk of IBM PS/2 Model 30, IBM PC/XT, and compatible computers. The card transfers data at 7.5 megabits/second and offers an average access time of 28 milliseconds. \$1,095. CMS Enhancements Inc., 1372 Valencia Ave., Tustin, CA 92680. (714) 259-9555. *Circle 18.*

ImageServer XP laser printers. These printers produce 20 pages/minute and support many page- and document-control languages. Model 5320 automatically collates and reverses pages and has three paper trays that hold 2,500 sheets. Model 6320 adds the ability to print on both sides of a page simultaneously. Both models include system software and a host/network interface. \$26,950 for the 5320; \$29,950 for the 6320. Imagen Corp., Box 58101, Santa Clara, CA 95052. (408) 986-9400. *Circle 19.*

JX-9300 laser printer. Handles six pages/minute with a resolution of 300×300 dots/inch. The product's standard 396-kilobyte memory can be expanded to 1.5 megabytes. One paper tray holds 100 sheets of plain paper; a slot lets users insert single sheets of letterhead or transparencies. Less than \$2,400. Sharp Electronics Corp., Systems Division, Sharp Plaza, Mahwah, NJ 07430. (201) 529-9500. *Circle 20.*

LP-286 laptop computer. This 15½-lb. unit has a 5×9-inch liquid-crystal display, a full-size keyboard, and a numeric keypad. The system includes a 20-megabyte hard disk, one megabyte of random-access memory, and a 1.44-megabyte 3½-inch disk drive, plus two serial ports and a parallel port. Runs off 110 or 220 volts, a 12-volt car lighter, or a battery pack. \$2,495. Dauphin Electronics, 1125 E. Saint Charles Rd., Lombard, IL 60148. (800) 782-7922; in Ill., (312) 627-4004. *Circle 21.*

Macintosh II extension kit. Lets Macintosh users position the monitor as much as eight feet from the central processor. The kit contains a six-foot power extension cord and a six-foot video-signal cable. \$49.95. Kensington Microwave Ltd., 251 Park Avenue South, New York, NY 10010. (800) 535-4242; in N.Y., (212) 475-5200. *Circle 22.*

Mac Laser Databank optical drive. A 5¼-inch write-once, read-many (WORM) optical-drive subsystem for the Macintosh SE and Macintosh II computers. Stores 400 megabytes per disk and uses all the facilities of Macintosh Finder and Multifinder. Software links the drive to the host computer's operating system. \$3,995. Optotech Inc., 770 Wooten Rd., Colorado Springs, CO 80915. (303) 570-7500. *Circle 23.*

Microline 183 personal printer. This five-inch-high printer, made for home offices, offers a wide cartridge to accommodate spreadsheets and oversized documents. The device prints 120 characters/second in draft mode, 30 characters/second in near-letter-quality mode. \$399. Okidata, 532 Fellowship Rd., Mount Laurel, NJ 08054. (609) 235-2600. *Circle 24.*

PC Access System optical drive. Lets IBM PC/XT/AT and compatible computers use OAS optical disks; supports both 5¼- and 12-inch drives. The subsystem includes an optical-disk drive, a SCSI interface card, and software compatible with PC-DOS or MS-DOS 3.0 and later versions. \$7,500. Aquidneck Systems International Inc., 650 Ten Rod Rd., North Kingstown, RI 02852. (401) 295-2691. *Circle 25.*

Smoke386 portable computer. An 80386-based, 20-megahertz machine with a black-on-white VGA display that offers 640×480-pixel resolution. The system includes a 5¼-inch floppy-disk drive, a modem, parallel and serial ports, and memory from 256 kilobytes to 1.25 megabytes. Runs only on AC power. Less than \$6,500. Datavue Corp., 1 Meca Way, Norcross, GA 30093. (404) 564-5668. *Circle 26.*

Z88 laptop computer. Measures 11½×8¼×7⅞ inches; weighs less than two lbs. The computer has a Z80 processor, 32 kilobytes of random-access memory (expandable to three megabytes), an 8-line×106-character liquid-crystal display, and a standard keyboard. Also has an RS-232C port; runs on four batteries. Software includes a program that mixes word-processing, spreadsheet, and database activities. \$499. Cambridge Computer Ltd., Sidney House, Sussex St., Cambridge, CB1 1PA, England. 44-223-312216. *Circle 27.*

■ COMPUTER SOFTWARE

BPTPLUS in C data manager. Allows both sequential and direct access to data; has programmable keys. The software lets users perform partial key searches and put 40 indexes in each file. Compatible with Borland Turbo C, Microsoft 3.0/4.0, and Lattice 3.0. Runs on IBM PC and compatible computers; written in the C language. \$79. Sterling Cas-

tle Software, 702 Washington St., Suite 174, Marina Del Rey, CA 90292. (800) 722-7853; in Calif., (800) 323-6406. *Circle 28.*

Daily Routine sales manager. Creates a daily agenda of follow-up activities, customer-history files, names and addresses, call reports, and quotation summaries. Also generates expense and mileage reports. Works on IBM-compatible computers. \$175. First Phase Inc., Box 4504, Greensboro, NC 27404. (919) 855-8858. *Circle 29.*

DeskWorks word processor. Lets those with IBM-compatible systems generate forms, use Greek and scientific characters, and handle math and statistics. The program offers a telephone directory, automatic dialing, a calendar, a scheduler, spelling correction, and a thesaurus. Works with Multimate Advantage, Samna, WordStar, WordPerfect 4.1, and other software. \$395 or \$495. Harris Corp., Lanier Business Products Sector, 1700 Chantilly Drive N.E., Atlanta, GA 30324. (404) 329-8000. *Circle 30.*

Impressionist 2.0 business graphics. Offers three levels to suit novices to experts; helps create charts and other business graphics. The package allows transfer of other software files into a program and provides a variety of colors and text fonts. Works with the IBM CMS and TSO operating systems on computers from IBM, DEC, and Prime with at least 512 kilobytes of memory. \$15,000 for the mainframe version, \$9,000 for the minicomputer version, and \$695 for the IBM PC-compatible version. Execucom Systems Corp., 9442 Capital of Texas Highway North, Arboretum Plaza One, Austin, TX 78759. (512) 346-4980. *Circle 31.*

Innovator brainstorming aid. Helps solve problems and generate ideas; uses a question-and-answer format to present solutions and help people develop analytical-thinking skills. Works with both individuals and groups; runs on the IBM PC. \$79.95. Liberty Software, 1814 S.W. 69th Terrace, Gainesville, FL 32607. (904) 332-5327. *Circle 32.*

Kernfastic typesetting modifier. Made for IBM PC-based Compugraphic MCS and PowerView typesetting systems; provides control over automatic kerning, including permanent modifications. \$149. The 'Puter Group, Box 9422, Madison, WI 53715. (800) 356-9021; in Wis., (800) 362-7212. *Circle 33.*

Legal Dictionary spelling checker. Includes 20,000 words and abbreviations used in the legal profession; comes as part of the 93,000-word Spellswell spelling-checker dictionary. \$99.95. Working Software Inc., 321 Alvarado, Suite H, Monterey, CA 93940. (408) 375-2828. *Circle 34.*

Omegamon protection software. Monitors dBase 2 software to warn of potential problems when processing exceeds user-defined limits. \$30,000. Candle Corp., 1990

■ NEW PRODUCTS ■

Bundy Drive, Los Angeles, CA 90025. (213) 207-1400. *Circle 35.*

Profiles financial/sales analyzer. Three programs for home buyers, real-estate professionals, and loan officers help develop financial profiles of clients. Users plug in interest rates and other variable information to examine financial options. \$395; rents for \$39 per month. QualiFile Inc., 960 Stone Hill Center, Suite 211, Fox River Grove, IL 60021. (312) 639-9330. *Circle 36.*

Publisher 1.0 desktop publisher. A high-end system for Sun workstations; helps produce complex documents such as books and scientific papers. The program handles equations and tables and offers paint and draw graphics to create publication-quality documents. \$1,995; \$895 for academic institutions. ArborText Inc., 535 West William St., Suite 300, Ann Arbor, MI 48103. (313) 996-3566. *Circle 37.*

Publishing Companion converter. Translates WordPerfect documents into the TeX typesetting language. The software includes a menu-driven program to create style sheets and offers automatic indexing. \$179. K-Talk Communications Inc., 3920 Olen-tangy River Rd., Columbus, OH 43214. (614) 459-9711. *Circle 38.*

Repair Writer auto-repair tracker. Generates automotive work orders, estimates, and invoices, keeping track of inventory and billing. The program includes a follow-up reminder system and compiles records of sales, percentages, and billed and earning rates. Works on IBM PC/XT/AT or compatible computers with DOS 2.0 or later versions. \$1,995. Small Business Computer Systems Inc., 313 Llewellyn Rd., Ambler, PA 19002. (215) 542-9639. *Circle 39.*

Roster Plus database. Helps organizations manage membership information; records billing information, personal histories, and comments for 16.7 million people. The program also generates reports, mailing labels, and disk files. It runs on IBM PC/AT/XT and compatible computers and also on the TI Professional and Monroe 2000. \$825. Conway Data Inc., 40 Technology Park/Atlanta, Norcross, GA 30092. (800) 554-5686; in Ga., (404) 446-6996. *Circle 40.*

The Complete PC tutorial. Teaches computing to novices, including basic computer concepts, operating systems, programming in Basic, and advanced use of DOS. Consists of 20 interactive lessons with graphics and windows; runs on IBM PC/XT/AT or compatible computers. \$49.95. Driver-Canning Inc., 1000 Quail St., Suite 190, Newport Beach, CA 92660. (714) 851-6202. *Circle 41.*

XChange transfer program. Automatically transfers all types of data files between IBM PC and compatible computers. The program lets users perform off-site file maintenance

on remote computers and provides records of activity. Data compression before transmission reduces long-distance telephone charges by as much as 80 percent. \$149.95. Nochange Software, 540 Silver Pine Trail, Roswell, GA 30076. (800) 255-4282; in Ga., (404) 587-3815. *Circle 42.*

■ COMMERCIAL/INDUSTRIAL

5103 vapor-deposition system. Made for high-volume production processing of advanced semiconductor devices. The cold-wall system has three vacuum chambers and performs selective tungsten deposition on wafers four to eight inches in diameter. \$950,000 to \$1.3 million. Varian Semiconductor Equipment Group, 611 Hansen Way, M.S. G-105, Palo Alto, CA 94303. (800) 544-4636. *Circle 43.*

6N137 optocoupler. Combines a GaAsP photon-emitting diode with an integrated-circuit photosensor to isolate DC and AC circuits. Compatible with LSTTL and TTL circuits; eliminates ground loops. \$2.22 each in lots of 1,000. TRW Electronic Components Group, Optoelectronics Division, 1215 West Crosby Rd., Carrollton, TX 75006. (214) 323-2200. *Circle 44.*

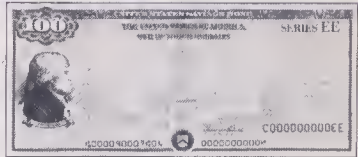
A-Plus design software. Version 5.0, made to cut design time for erasable programmable logic devices by as much as 20 times. Runs on IBM PC or compatible computers. \$1,750. Altera Corp., 3525 Monroe St., Santa Clara, CA 95051. (408) 984-2800. *Circle 45.*

Crossatron modulator switch. A gridded, crossed-field switch made for high-power modulators. The device uses a cold cathode to generate a high-density plasma. About \$10,000. Hughes Aircraft Company, Electron Dynamics Division, Box 2999, Torrance, CA 90509. (213) 568-6307. *Circle 46.*

HP 3235A switch modules. These plug-in switches work with the 3235A switch/test unit. The modules include a relay driver for microwave switching, two dense armature relays, an AC/DC source, a digital-to-analog converter, and an HP-IB controller. The company also offers microwave accessories for switching signals to 26.5 gigahertz. \$600 to \$2,500. Hewlett-Packard Company, 1820 Embarcadero Rd., Palo Alto, CA 94303. Call local sales office. *Circle 47.*

HP 8702A photonic analyzer. This system helps design and analyze high-bandwidth or high-bit-rate lightwave components, including fiber-optic transmitters, receivers, and couplers. It measures the modulation-transfer function of optical components operating to three gigahertz.

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\$28,000. Hewlett-Packard Company, 1820 Embarcadero Rd., Palo Alto, CA 94303. Call local sales office. *Circle 48.*

Informix-ESQL/Ada software. Written for the Unix-based Macintosh II A/UX, this program lets users embed SQL syntax in Ada code to create a database that works with the company's SQL database engine. \$1,600 to \$3,000. Informix Software Inc., 4100 Bohannon Drive, Menlo Park, CA 94025. (415) 322-4100. *Circle 49.*

PowerProbe diagnostic boards. These printed-circuit boards monitor the internal power of microcomputers to help design and repair IBM-compatible computers, the IBM PS/2, and the Apple Macintosh II. \$489. Applied Physics Inc., Box 2368, Purdue Research Park, West Lafayette, IN 47906. (317) 497-1718. *Circle 50.*

Prisma design system. For designing printed-circuit boards; includes real-time integration, interactive layout graphics, automatic routing, and post-processing for manufacturing. This hardware/software package includes a 32-bit Sun 3 or 4 workstation. \$139,800 for a Sun 3/60 version. Calay Systems Inc., 2698 White Rd., Irvine, CA 92714. (714) 863-1700. *Circle 51.*

Superconducting levitation kit. This demonstration kit has a superconducting-ceramic disk made of yttrium oxide, barium oxide, and copper oxide that exhibits the Meissner effect of magnetic levitation. The kit includes a rare-earth cobalt magnet. \$45. Edmund Scientific Co., 5554 Edscorp Building, Barrington, NJ 08007. (609) 547-3488. *Circle 52.*

RAMdisk/ALX storage subsystem. Provides one gigabyte of storage for Unisys A, V, and BX900 mainframe computers. The subsystem uses one-megabit random-access memories to process more than 1,200 input/outputs per second. Includes battery backup, plus error detection and correction. From \$159,000 for a 128-megabyte system; from \$610,000 for a one-gigabyte version. Zitel Corp., 630 Alder Drive, Milpitas, CA 95035. (408) 946-9600. *Circle 53.*

RotoPlus power-line isolator. A frequency changer that guards sensitive data by preventing it from leaving the computer and traveling through power lines. Accessories include load/line isolators, power-frequency phase and/or voltage converters, and power conditioners. \$2,000 to \$20,000. International Computer Power Inc., 501 S. Michillinda Ave., Pasadena, CA 91107. (818) 793-8656. *Circle 54.*

RT Ada software-design system. Includes an Ada run-time system and cross-development software for designing real-time applications. Runs on DEC VAX/VMS workstations to handle the 1750A and Motorola 68000 processors. \$26,000 to \$108,000. Ready

Systems, 449 Sherman Ave., Box 61029, Palo Alto, CA 94306. (415) 326-2950. *Circle 55.*

TechGraphPad software. Engineering software that plots test data, taps into information stored in spreadsheets, and generates graphs and plots. Runs on IBM PC/XT/AT and compatible computers. \$275. Binary Engineering, 100 Fifth Ave., Waltham, MA 02154. (617) 890-1812. *Circle 56.*

TLM502A1 LED module. Composed of 256 T1 light-emitting-diode lamps in a 16x16 matrix. The module offers red, green, and amber lamps and uses digital RGB driving circuits. \$150 each in lots of 100. Toshiba America Inc., Semiconductor Products Division, 2692 Dow Ave., Tustin, CA 92680. (714) 832-6300. *Circle 57.*

TSC500A converter processor. Contains all the analog circuitry needed to build an integrating analog-to-digital converter; lets designers control all measurement functions through two logic input signals. The device can be modified with microprocessor software to trade off between resolution and conversion speed. \$79.50 for an evaluation kit. Teledyne Semiconductor, 1300 Terra Bella Ave., Mountain View, CA 94039. (800) 888-9966; in Calif., (415) 968-9241. *Circle 58.*

VM Fax communications software. Allows users to send facsimile copies from IBM-compatible terminals. The software offers automatic dialing, priority transmission, and programmable time and date transmission; also lets users send one fax to multiple destinations. Works with IBM's Profs office-automation system; runs on IBM 9370 computers. About \$30,000. Systems & Telecoms Inc., Suite 100, 12020 Sunrise Valley Dr., Reston, VA 22091. (703) 391-2712. *Circle 59.*

■ CONSUMER PRODUCTS



HS-C30U Super VHS-C camcorder. Offers a horizontal resolution of 400 lines to surpass broadcast-television quality. The camera/recorder has a four-speed shutter and an audio/video input for dubbing from or to another recorder. \$1,600. Mitsubishi Electric Sales America Inc., Box 6007, Cypress, CA 90630. (714) 220-2500. *Circle 60.*

CR-4A three-head tape deck. Unlike most other three-head decks, the heads on this cassette deck are physically and magnetically independent, allowing individual adjustment. The deck includes an automatic tape-calibration system. \$995. Nakamichi America Corp., 19701 S. Vermont Ave., Torrance, CA 90502. (800) 421-2313; in Calif., (800) 223-1521. *Circle 61.*

Guild of Thieves computer game. This adventure puzzle game takes place in the mythical kingdom of Kerovnia and includes a Bank of Kerovnia credit card. Versions for Tandy, Atari ST, Amiga, Macintosh, and IBM-compatible computers cost \$44.95; versions for the Commodore 64/128, Apple II, and Atari 8-bit computers are \$39.95. Firebird, 71 Franklin Turnpike, Waldwick, NJ 07463. (201) 444-5700. *Circle 62.*

Jewels of Darkness computer game. An adventure game set in a world of demons, elves, and magicians. \$24.95 on Commodore 64/128, Atari, Amiga, Tandy, and IBM-compatible computers; \$29.95 for Macintoshes. Firebird, 71 Franklin Turnpike, Waldwick, NJ 07463. (201) 444-5700. *Circle 63.*

RD-350/450 car radio/tape decks. These two receiver/cassette decks offer self-contained power amplifiers. Both models use a head-rotating mechanism to ensure accurate alignment. The RD-450 has inputs for a compact-disc player. \$395 and \$529. Nakamichi America Corp., 19701 S. Vermont Ave., Torrance, CA 90502. (800) 421-2313; in Calif., (800) 223-1521. *Circle 64.*

RL-35 speakers. Dimensions are about 15x12x5 inches. Because the speaker cabinets have curved lines with no parallel or reflecting surfaces, they do not produce audible vibrations of their own and will not alter sound reproduction. \$380 per pair. Bang & Olufsen of America Inc., 1150 Feehanville Dr., Mount Prospect, IL 60056. (800) 323-0378. *Circle 65.*

RX-222 car radio/tape deck. Has 12 preset stations and a stereo/mono switch; offers automatic station scanning and tape rewind. The deck also has a power fader for use with four speakers, plus bass, treble, and balance controls. \$169.95. Sansui Electronics Corp., 1250 Valley Brook Ave., Lyndhurst, NJ 07071. (201) 460-9710. *Circle 66.*

SR38/340 car radio/tape decks. The SR38 stereo receiver/cassette deck has a 5-band graphic equalizer to conform sound to a car's interior. The SR340 automatically scans for stations and offers a liquid-crystal time/frequency display. \$79.99 and \$99.99. Sparkomatic Corp., Milford, PA 18337. (800) 233-8831; in Pa., (800) 592-8891. *Circle 67.*

WM-F109 Walkman. Has remote controller attached to headphone cord. \$229.95. Sony Corp., 9 West 57th St., New York, NY 10019. (212) 418-9470. *Circle 68.*

MARKETWATCH

NEW COMPANIES

| COMPANY | BUSINESS OBJECTIVE | FINANCING | OFFICERS | OFFICERS' PREVIOUS POSTS |
|---|---|---|--|---|
| Advantage Production Tech. 4208 Balloon Park Rd., N.E. Albuquerque, NM 87109 (505) 344-6868 | To design and produce thin-film deposition systems based on proprietary technology developed by the founder. | Undisclosed funds from founder | Michael McNeilly, founder, president, CEO | Applied Materials, president, founder |
| Aspen Semiconductor 195 Champion Court San Jose, CA 95134 (408) 943-2105 | To design, develop, and market ultra-high-speed bipolar integrated circuits, including memory devices and programmable logic devices. | \$7.4 million in first round from Cypress Semiconductor | T.J. Rodgers, chairman Narpat Bhandari, president, CEO | Cypress Semiconductor, president (current) Fairchild Semiconductor, engineering manager |
| BFM Aerospace 2040 E. Dyer Rd. Santa Ana, CA 92705 (714) 250-1010 | To acquire and operate three of Lear Siegler's divisions. | \$103 million from leveraged buyout of executives | Barry Rodgers, president, chairman William Chomko, v.p. finance | Lear Siegler, v.p. group operations Lear Siegler, v.p. group finance |
| Denning Systems Group 21 Concord St. Wilmington, MA 01887 (617) 658-7800 | To sell Denning Mobile Robotics' robots to research laboratories. | Undisclosed funds from parent company, Denning Mobile Robotics | George Leccese, v.p. | Denning Mobile Robotics, v.p. operations (current) |
| Electronic Data Technologies 3155 W. Harmon Las Vegas, NV 89103 (702) 798-8112 | To make microcomputer-based information systems that help casinos identify and reward people who spend a lot of time playing their slot machines. | \$4,025,000 from initial public offering | Charles Mathewson, chairman William R. Dukes, president | ITT, president, CEO (current) Pasar, president, CEO |
| Innovis Interactive Technologies Tacoma, WA 98477 (206) 924-2900 | To develop computer-based, interactive training systems that help improve marketing, training, and decision-making skills. | Undisclosed funds from Weyerhaeuser | Mark Lembersky, president Uli Chi, v.p. | Weyerhaeuser's Engineered Products, general manager Decision Simulators, program manager |
| Logical Training Systems 240 East Ave. Rochester, NY 14604 (716) 262-2226 | To develop and produce IBM PC and Macintosh software training materials for corporate, government, and training-center customers. | Undisclosed funds from parent company, Logical Operations | Barry M. Keesan, president William A. Rosenthal, v.p. sales & marketing | Logical Operations, founder, president (current) Bayer U.S.A., national account director |
| Molecular Dynamics 240 Santa Ana Court Sunnyvale, CA 94086 (408) 773-1222 | To develop, manufacture, and sell biomolecular separation and measurement systems. | \$43 million from Domain Associates and New Enterprise Associates | James Schlater, president, co-founder | Applied Biosystems, senior v.p. |
| Reynolds Polymer Technologies 311 E. Alton Ave. Santa Ana, CA 92707 (714) 957-3002 | To manufacture large acrylic products cast in one piece. | Undisclosed funds from parent company, Reynolds & Taylor | Roger Reynolds III, president | Reynolds & Taylor, v.p. Acrylic div. |
| Salesnet 2300 Fifth Ave. Fort Worth, TX 76110 (817) 924-0632 | To provide a satellite system to transmit video or data nationally and internationally for sales, promotional, and training videos. | \$100,000 from founder | Alan Simpson, president, founder | Satellite Communications Ltd., president (current) |
| Transgenic Sciences 365 Plantation St. Worcester, MA 01605 (617) 797-0503 | To develop improved chickens and turkeys, including hens that lay low-cholesterol eggs. | Undisclosed funds from Commonwealth BioVentures | F. Donald Hudson, chairman, co-founder Cha Mer Wei, v.p. research, co-founder | Organogenesis, co-founder, director (current) Oncogene, sr. scientist |

CONTRACTS AWARDED

| AWARDED TO | AWARDED BY | AMOUNT | PURPOSE |
|---|--|-------------------------|---|
| Apollo Computer 330 Billerica Rd. Chelmsford, MA 01824 (617) 256-6600 | U.S. Department of Transportation | \$2.6 million | To supply workstations for a new air-traffic management system designed to avoid flight delays and enhance safety. |
| Auto-trol Technology 12500 N. Washington St. Denver, CO 80233 (303) 452-4919 | U.S. Department of the Interior; Fish and Wildlife Service | \$700,000 | To provide eight computer-aided design and drafting systems; options would expand the total number of systems to 19 in two years. |
| Boeing Advanced Systems Box 3707, M.S. 4H-14 Seattle, WA 98124 (206) 655-1198 | NASA | \$7.4 million | To develop and test critical technologies for planes that can fly into orbit. |
| Boeing Advanced Systems Box 3707, M.S. 4H-14 Seattle, WA 98124 (206) 655-1198 | U.S. Air Force | \$753,000 | To develop tires for planes that take off and land at 250 to 350 miles per hour; subcontractors are B.F. Goodrich and Bendix Aerospace. |
| Boeing Military Airplane Box 7730, M.S. K15-12 Wichita, KS 67277 (316) 526-3153 | U.S. Air Force | \$60 million | To prepare for production of the Seek Spinner—an unmanned, propeller-driven aircraft that finds and attacks radar installations. |
| British Telecom 55 Broadway New York, NY 10006 (212) 797-9500 | Bank of Nova Scotia, Amsterdam Rotterdam Bank, Westdeutsche Landesbank, and Banca Nazionale del Lavoro | More than \$3 million | To install integrated trading systems at the banks' offices in New York and other cities. |
| Centel Communications Systems 8725 Higgins Rd. Chicago, IL 60631 (312) 399-5160 | California State University at Los Angeles | \$6.2 million | To design, install, and maintain an integrated voice/data digital-telecommunications network. |
| Cray Research 608 Second Ave. South Minneapolis, MN 55402 (612) 333-5889 | NASA's Ames Research Center | \$54 million | To supply an advanced computer system for use in NASA's Aerodynamic Simulation Processing System Network. |
| Dekker 214 E. Olive Ave. Redlands, CA 92373 (714) 793-7939 | Telos | \$2-million subcontract | To develop, maintain, and operate a system for program management and information control for the Joint Tactical Fusion Program (main contract from the Jet Propulsion Laboratory). |
| Endevco 30700 Rancho Viejo Rd. San Juan Capistrano, CA 92675 (714) 493-8181 | Boeing Commercial Airplane | Not disclosed | To provide engine-vibration monitors as basic equipment on various jet aircraft. |
| Environmental Systems Research 380 New York St. Redlands, CA 92373 (714) 793-2853 | U.S. Geological Survey | Not disclosed | To supply research software to the Interior Department and the U.S. Army Engineering Topological Laboratory. |
| Ericsson 100 Park Ave. New York, NY 10017 (212) 685-4030 | Commission of the European Communities | Not disclosed | To enter the Research in Advanced Communication in Europe (RACE) program, developing a European broadband network for the late 1990s. |
| Ericsson 100 Park Ave. New York, NY 10017 (212) 685-4030 | Macao, Cyprus, and United Arab Emirates | \$50 million | To install cellular radio system equipment. |

■ MARKETWATCH ■

| AWARDED TO | AWARDED BY | AMOUNT | PURPOSE |
|---|---|---------------|---|
| GE Aerospace Route 38 Cherry Hill, NJ 08358 (609) 486-6392 | NASA | \$800 million | To design, develop, launch, and activate Work Package III, part of the space station. |
| GE Transportation Systems 2901 East Lake Rd. Erie, PA 16531 (814) 875-3457 | U.S. Department of Energy | \$17 million | To develop an internal-combustion engine that runs on coal. |
| Genetics Institute 87 Cambridge Park Dr. Cambridge, MA 02140 (617) 876-1170 | Sandoz | Not disclosed | To supply GM-CSF, a drug that stimulates the body's defenses to fight infection. |
| Government Technology Services 14130 8 Sully Field Circle Chantilly, VA 22021 (703) 631-3333 | U.S. Department of Health and Human Services | \$2.1 million | To supply Kaypro computers and peripheral equipment to the department's Office of Alcohol, Drug, and Mental Health Abuse. |
| Harris, Controls & Compositions 407 John Rodes Blvd., Box 430 Melbourne, FL 32909 (305) 242-5000 | Los Angeles County Transportation Commission | \$3.6 million | To provide a control and data-acquisition system for a new rapid-transit line. |
| Hughes, Radar Systems Box 92426 Los Angeles, CA 90009 (213) 647-0181 | Rockwell International | \$58 million | To develop and produce a fire-control radar system for the AC-130U gunship. |
| Industrial Technology Institute Box 1485 Ann Arbor, MI 48106 (313) 769-4000 | Materials Laboratory, Wright-Patterson Air Force Base | \$194,500 | To perform nondestructive tests of parts for use in a machine-vision development project at the University of Michigan. |
| McDonnell Douglas Box 516 St. Louis, MO 63166 (314) 232-5521 | U.S. Air Force | \$1.2 million | To receive technology from General Dynamics, the prime contractor for the Advanced Cruise Missile, to become a second source for the missile. |
| Memtek 28 Cook St. Billerica, MA 01821 (617) 667-2828 | Martin Marietta | \$332,000 | To design and build a membrane filtration system to handle radioactive wastewater. |
| Palette Systems 2 Burlington Woods Park Burlington, MA 01803 (617) 273-5660 | Harris, Government Systems Division | Not disclosed | To provide the graphics component of an integrated system for developing automatic tests of microelectronic circuits. |
| Palette Systems 2 Burlington Woods Park Burlington, MA 01803 (617) 273-5660 | Liton Industries | Not disclosed | To supply VT340 terminals, which will display manufacturing instructions as a reference for factory workers. |
| RCA Government Services Route 38 Cherry Hill, NJ 08358 (609) 486-5174 | NASA | \$50 million | To provide science-payload development, engineering, and operations services at the Johnson Space Center. |
| RCA Government Services Route 38 Cherry Hill, NJ 08358 (609) 486-5174 | Tyndall and Holloman Air Force Bases | \$26 million | To supply aerial targets and support the Gulf Range Drone Control Upgrade System. |
| Sentient Systems Technology 5001 Baum Blvd. Pittsburgh, PA 15213 (412) 682-0144 | U.S. Navy | \$50,000 | To develop a helmet-mounted sensor that tracks a person's gaze, allowing the person to activate a switch by looking at it. |

| AWARDED TO | AWARDED BY | AMOUNT | PURPOSE |
|---|---|----------------|---|
| Singer SimuLite Training Box 619119 Dallas/F.W. Airport, TX 75261 (214) 456-8000 | U.S. Air Force, Tactical Air Command | \$13.7 million | To train pilots to fly the F-16, using both classes and simulations. |
| Singer SimuLite Training Box 619119 Dallas/F.W. Airport, TX 75261 (214) 456-8000 | U.S. Air Force, Tactical Air Command | \$1.7 million | To provide classroom instruction for reconnaissance pilots and weapon-system operators on the RF-4 Phantom. |
| Southern Methodist University Box 174 Dallas, TX 75275 (214) 987-9844 | Defense Advanced Research Projects Agency (DARPA) | \$3.8 million | To design and develop a facility to serve as the prototype for a nuclear-test-ban verification research center. |

MERGERS

| COMPANY | BUSINESS | COMPANY | BUSINESS | NEW NAME |
|---|--|--|---|------------------------------|
| Amnicon 340 Wildcat Rd., Downsview Ontario, Canada M3J 2N5 (416) 667-8461 | Makes products molded of polyurethane plastic, including Symmetry computer furniture | National Iron Resources 340 Wildcat Rd., Downsview Ontario, Canada M3J 2N5 (416) 667-8461 | Mining | Amnicon |
| Interactive Training Sys. 9 Oak Park Dr. Bedford, MA 01730 (617) 271-0500 | Develops laser-disc products for corporate training and consumer-activated sales systems | Spectrum Training 50 Salem St. Lynnfield, MA 01940 (617) 245-8500 | Provides training and systems for data processing, telecommunications, and financial services | Undetermined |
| SGS Semiconductor 1000 E. Bell Rd. Phoenix, AZ 85022 (602) 867-6100 | Manufactures semiconductor devices | Thomson/Mostek 1216 Electronic Dr. Carrollton, TX 75006 (214) 466-6000 | Manufactures integrated circuits | SGS-Thomson Microelectronics |
| Vedavi Technology 8300 E. Raintree Dr. Scottsdale, AZ 85260 (602) 998-2200 | Makes telecommunications systems and office-automation products | Isoetec Communications 6 Thorndal Circle Darien, CT 06820 (203) 655-6500 | Supplies business communication systems | Undetermined |

ACQUISITIONS

| BUYER | BUSINESS | COMPANY ACQUIRED | BUSINESS | AMOUNT |
|--|--|--|---|--|
| AT&T 100 Southgate Parkway Morristown, NJ 07960 (201) 898-2000 | Makes communications equipment, computers, and software | Sun Microsystems 2550 Garcia Ave. Mountain View, CA 94043 (415) 960-1300 | Makes workstations for computer-aided design, software development, artificial intelligence | \$300 million (for a 20-percent share) |
| Epitope 15425 S.W. Koll Parkway Beaverton, OR 97006 (503) 641-6115 | Biotechnology; supplies tests for various diseases, including AIDS | Agricultural Genetic Systems 15425 S.W. Koll Parkway Beaverton, OR 97006 (503) 641-6115 | Agricultural biotechnology; develops tests and treatments for plants and animals | \$400,000 |
| Fisher Controls International 205 S. Center St. Marshalltown, IA 50158 (515) 754-3011 | Makes control valves, regulators, and measurement instruments | Exac 1370 Dell Ave. Cambell, CA 95008 (408) 374-6810 | Makes Coriolis mass-flow meters | Not disclosed |
| MacNeal-Schwendler 815 Colorado Blvd. Los Angeles, CA 90041 (213) 258-9111 | Develops structural-analysis engineering software | Cad Comp 9076 N. Dearbrook Trail Milwaukee, WI 53223 (414) 357-8723 | Engineering consulting; also develops software for electromagnetics analysis | Less than \$1 million |

| BUYER | BUSINESS | COMPANY ACQUIRED | BUSINESS | AMOUNT |
|---|---|--|---|----------------|
| Micom Systems 4100 Los Angeles Ave. Simi Valley, CA 93062 (805) 583-8600 | Supplies data-communications equipment and network subsystems | Spectrum Oigitol 455 Spring Park Pl. Herndon, VA 22070 (703) 478-0560 | Makes T1 multiplexers for communications networks | \$19.4 million |
| Modular Computer Systems Box 6099 Fort Lauderdale, FL 33340 (305) 974-1380 | Supplies real-time computers and services | Computrol 15 Ethon Allen Hwy. Ridgefield, CT 06877 (203) 544-9371 | Develops local-area networks for factories and nuclear-power-plant security | Not disclosed |
| Optilink 1310 Redwood Way Petaluma, CA 94952 (707) 795-9444 | Manufactures digital loop carriers | Ericsson's domestic subscriber group 1810 North Glonville Richardson, TX 75081 (214) 680-9770 | Builds Timespan digital-loop-carrier and S68 analog-carrier systems | Not disclosed |
| Recognition Equipment Box 660204 Dallas, TX 75266 (214) 579-6000 | Makes data-capture systems for computers | Mohawk Data Sciences 235 Hood Rd., Markham Ontario, Canada L3R4N5 (416) 475-6060 | Sells and services data-capture equipment | \$10.3 million |
| Vapor Technologies 1 Bradford Rd. Mount Vernon, NY 10553 (914) 664-1495 | Provides coating services | Wedtech's coatings division 15 West 37th St. New York, NY 10018 (212) 391-4418 | Develops coating technology and provides coating services | \$4.25 million |
| Vodavi Technology 8300 E. Raintree Dr. Scottsdale, AZ 85260 (602) 998-2200 | Makes telecommunications systems and office-automation products | Contel Executive 5550 Triangle Parkway Norcross, GA 30092 (404) 391-8000 | Supplies business telephone systems | \$60 million |

JOINT VENTURES

| COMPANY | COMPANY | PURPOSE | CONTACT |
|---------------------|---|--|---|
| AT&T | Bowman Gray/Baptist Hospital Medical Center | To implement and demonstrate new communications technology. | AT&T 480 Red Hill Rd. Middletown, NJ 07748 (201) 615-4848 |
| Eastman Kodak | Fuquo Industries | To combine their photofinishing operations. | Eastman Kodak 343 State St. Rochester, NY 14658 (716) 724-4816 |
| Gold Hill Computers | Autodesk | To create a training course for programming in AutoLisp; the course will be offered at AutoCAD training centers. | Gold Hill Computers 26 Lonsdowne St. Cambridge, MA 02139 (617) 621-3300 |
| Matsushita Electric | Ultra Technologies (a Kodak subsidiary) | To build a battery-manufacturing facility in the United States. | Matsushita News Center 1 Ponosonic Way Secaucus, NJ 07094 (201) 348-7320 |
| SmithKline Beckman | Suntory | To collaborate in pharmaceutical research and development. | SmithKline Beckman Box 7929 Philadelphia, PA 19101 (215) 751-4000 |
| Whirlpool | Vitro S.A. (Mexico) | To form a Mexican venture to manufacture and sell major home appliances. | Whirlpool 2000 Michigan Hwy. 63 Benton Harbor, MI 49022 (616) 926-5000 |

RESEARCH REPORTS

| STUDY BY | TITLE | FORECAST | PRICE |
|--|---|---|---------|
| Able Communications 515 Kevenoire Dr. Milpitas, CA 95035 (408) 945-1484 | Data-Over-Voice Systems (# D8) | The \$20 million of new revenue for 1987 will grow to \$60 million by 1990. | \$1,600 |
| Arthur D. Little 17 Acorn Park Cambridge, MA 02140 (617) 864-5770 | Biochips and Biosensors: Poised for Commercialization | Estimates world markets for biosensors to the year 2000; covers research and development, applications, and contenders. | \$1,800 |
| Business Communications 25 Von Zant St. Norwalk, CT 06855 (203) 853-4266 | Inert Ingredients for Drugs (# C-068) | The current market of \$1.1 billion per year will reach \$1.3 billion by 1991. | \$2,450 |
| Business Communications 25 Van Zant St. Norwalk, CT 06855 (203) 853-4266 | The Superconductor Component Industry (# G8-106) | Estimated 1987 market of \$585 million will grow to \$1.4 billion by 1991 and to \$1.8 billion by 2000. | \$1,950 |
| First Market Research 121 Beach St. Boston, MA 02111 (617) 482-9080 | The Bar-Code Scanner and Printer Market in Japan | The market for all product segments will increase 20 to 30 percent through 1991. Profiles manufacturers and future products. | \$990 |
| First Market Research 121 Beach St. Boston, MA 02111 (617) 482-9080 | The Visual-Sensor-System Market in Japan | Gives market share by manufacturer; reviews technology and market strategy. | \$1,800 |
| Frost & Sullivan 106 Fulton St. New York, NY 10038 (212) 233-1080 | The Digital Process-Controls Market in the United States (# A1782) | The market will climb from \$775 million in 1986 to \$935 million in 1989, topping \$1 billion by 1991. Includes reports on exports by U.S. companies. | \$2,150 |
| Market Intelligence Research 2525 Charleston Rd. Mountain View, CA 94043 (415) 961-9000 | Analytical Instrument Markets in Process Control (# A264) | The market will go from \$600 million in 1986 to more than \$2.1 billion by 1993. Looks at competitive factors and opportunities. | \$995 |
| Market Intelligence Research 2525 Charleston Rd. Mountain View, CA 94043 (415) 961-9000 | Patient-Assist Device Markets (# A189) | Demand for devices such as wheelchairs, orthopedic products, and therapy equipment will reach \$286 billion in 1993, triple the 1986 level of \$850 million. | \$995 |
| Technical Insights 32 N. Dean St. Englewood, NJ 07631 (201) 568-4744 | Neurocomputing: The Technology, the Players, the Potential | The market for computers that emulate the brain will grow from \$7 million in 1987 to \$570 million by 2000. Early markets will include defense/aerospace and expert systems. | \$1,350 |
| Technology Futures 6034 W. Courtyard Dr. Austin, TX 78730 (512) 343-6468 | Superconductivity: A Practical Guide for Decision Makers | Reviews potential applications for superconductors to help managers understand the technology's effect on their business. | \$595 |
| Technology Management Group 25 Science Park New Haven, CT 06511 (203) 786-5445 | The Impact of Biotechnology on Agricultural Chemicals | Reviews the world market for biological insecticides, pheromones, fungicides, plant-growth regulators, fertilizers, and seeds. | \$2,990 |
| Technology Management Group 25 Science Park New Haven, CT 06511 (203) 786-5445 | High-Technology Pregnancy—A Survey of Products, Services, and Markets | Evaluates markets for human-fertility products, including reviews of products to diagnose and treat infertility. | \$2,200 |

COMPANY INDEX

The following is a list of companies mentioned in this issue and the pages on which they appear. Companies mentioned in Marketwatch and the High Technology Business Leading 100 are not included.

| | | | | | |
|--------------------------------------|--------|--|----------------|--------------------------------------|--------|
| AST Research | 53 | GammaLink | 53 | North American Philips | 28 |
| AT&E | 36 | Gartner Group | 47 | Northern Light and Picture | 26 |
| AT&T | 44 | Gene Labs | 20 | Nove Pharmaceuticals | 20 |
| Aerojet Techsystems | 9 | Genentech | 20 | Okidata | 54 |
| Aeronautical Systems Group | 9 | General Electric | 25 | Omni Communications | 34 |
| Allied-Signal | 11 | General Motors | 17, 39, 42, 64 | Optotech | 54 |
| Altera | 55 | General Technology Applications | 10 | Orcle | 15 |
| American Home Products | 22 | Genetics Institute | 21 | Orchid Technology | 53 |
| Amgen | 21 | GeoNet Mailbox Systems | 36 | PecTel Paging | 38 |
| Ampex | 26 | Graphic Scanning | 33 | PegeWatch | 35 |
| Amstrad | 53 | Home Box Office | 27 | Paging Network | 36 |
| Apple Computer | 13 | HTI Custom Research | 10 | Paine Webber | 20 |
| Applied Biotechnology Laboratory | 9 | Hambrecht & Quist | 20 | Panasonic Industrial | 32 |
| Applied Immune Sciences | 20, 23 | Harris | 54 | Pansophic Systems | 47 |
| Applied Physics | 56 | Hattori Seiko | 11, 36 | Pfizer | 22 |
| Aquidneck Systems International | 54 | Helmets Limited | 40 | Philips | 25 |
| ArborText | 55 | Hewlett-Packard | 55 | Philips Telecom Equipment | 32 |
| Armstrong Aerospace Medical Research | 40 | Hitachi | 15, 26 | Pioneer Electronics | 64 |
| Arthur D. Little | 9, 36 | Honda | 64 | Plastic Engineering | 41 |
| Arthur Young | 46 | Honeywell | 11 | Polycell | 23 |
| Assn. of Maximum Service Telecasters | 27 | Hughes Aircraft | 13, 55 | Progenx | 21 |
| AudioVox | 64 | Hybritech | 22 | Prudential Bache | 23 |
| BASF | 11, 23 | IBM | 13, 17 | QualiFile | 55 |
| Bang & Olufson of America | 56 | Ikegami | 26 | Quest Biotechnology | 23 |
| Baxter Healthcare | 21 | Imagen | 54 | Recal Acoustics | 40 |
| Beeper Plus | 34 | Immunomedics | 20 | Racore Computer Products | 53 |
| Binary Engineering | 56 | Index Technology | 44 | Ready Systems | 56 |
| Biogen | 21 | Informix Software | 56 | Rebo High-Definition | 28 |
| Biomedical Business International | 18 | Ingersoll-Rand | 9 | Reebok | 26 |
| Blaupunkt | 64 | Integrated Genetics | 23 | Repligen | 23 |
| Boeing | 39, 42 | Intel | 53 | Ricoh | 53 |
| Bose | 40 | Intelligent Quotations | 34 | Rinspeed | 64 |
| Bridgestone Tire | 11 | International Computer Power | 56 | Rolm | 17 |
| Bristol-Myers | 17, 22 | International Data | 10, 15 | SRI International | 28 |
| Cadre Technologies | 47 | J.C. Penney | 26 | Sensui Electronics | 56 |
| Calay Systems | 56 | Johnson & Johnson | 21 | Sanyo | 26 |
| California Biotechnology | 20 | K Mart | 26 | Sarnoff Research Center | 27 |
| Cambridge Computer | 54 | K-Talk Communications | 55 | Scarsdale Security Systems | 35 |
| Canadian Broadcasting Company | 26 | K.K. Ashisuto | 15 | Scimed Life Systems | 17 |
| Candle | 54 | Kensington Microwave | 54 | Seers | 26 |
| Canon USA | 53 | Kentek Information Systems | 53 | Selectronics | 53 |
| Cenpolar | 9 | Kenwood | 64 | Sharp Electronics | 8, 53 |
| Cardis | 17 | Kidder, Peabody | 10 | Small Business Computer Systems | 55 |
| Centocor | 22 | Kirin Brewery | 21 | Sony | 26, 56 |
| Cetus | 22 | Kleiner, Perkins, Ceufield & Byers | 21 | Sony Communications Products | 26 |
| Chiron | 21 | Knowledgeware | 44 | Sparkomatic | 56 |
| Coca-Cola Bottling Consolidated | 34 | Kopin | 11 | Star Micronics | 53 |
| Code-A-Phone | 8 | Land Mobile Communications Council | 28 | Sterling Castle Software | 54 |
| Colorado Video | 53 | Liberty Software | 54 | Stretus Computer | 36 |
| Commonwealth Bioventures | 21 | Liposome Company | 20 | Sun Exploration & Production | 46 |
| Computer Associates | 17 | Lockheed | 8, 48 | Syntex | 22 |
| Consulting Resources | 20 | Los Alamos National Laboratory | 11 | Systems & Telecoms | 56 |
| Convergent Technologies | 46 | Management Science America | 15 | Systems Integration Associates | 54 |
| Conway Data | 55 | Matsushita | 26 | T Cell Sciences | 22 |
| Creative Biomolecules | 20 | Media Laboratory | 26 | TRW Electronic Components Group | 55 |
| Daiken | 9 | Medtronics | 17 | Tendern Computers | 15 |
| Datavue | 54 | Merck | 20 | Tendern Enterprises | 64 |
| Dauphin Electronics | 54 | Metriplex Systems | 33 | Tendy | 53 |
| Del Rey Group | 25, 28 | Metrocast | 32 | Tarkenton Software | 44 |
| Dial Page | 34 | Metromedia Paging | 36 | Technical Insights | 11 |
| Digisonix | 41 | Micron Technology | 54 | Technology Management Group | 11 |
| Digital Equipment | 13, 15 | MiniScoreboard | 35 | Teletronics Holdings | 17 |
| Douglas Aircraft | 42 | Minotaur Capital Management | 40 | Teledyne Semiconductor | 56 |
| Driver-Canning | 55 | Mitsubishi | 26 | Telocator Network of America | 36 |
| E.F. Hutton | 34 | Mitsubishi Electric Sales America | 56 | Texas Instruments | 47 |
| Edmund Scientific | 56 | Mobile Communications Corp. of America | 36 | The 'Puter Group | 54 |
| Electrical Power Research Institute | 42 | Montgomery Securities | 22 | Thompson CSF | 17 |
| Electronic Data Systems | 17 | Mostek | 17 | Tiere Computer Systems | 53 |
| Ell Lilly | 17, 20 | Motorole | 17, 28, 32 | Toshiba | 26, 56 |
| Endotronics | 18 | Multitone Electronics | 32 | Transgenic Sciences | 21 |
| Enhancements | 54 | NEC | 15, 26, 32 | UCCEL | 17 |
| Equity Group | 20 | NHK | 25 | UniPage | 33 |
| Execucum Systems | 54 | Nakemichi America | 56 | United Technologies | 17 |
| Federal Communications Commission | 28 | Nastec | 46 | Verien Semiconductor Equipment Group | 55 |
| Firebird | 56 | National Association of Broadcasters | 26 | Venture Funding | 23 |
| First Boston | 9 | National Cable Television Association | 27 | Vestar | 20 |
| First Phase | 54 | National Satellite Paging | 36 | Working Software | 54 |
| Fitzgerald Telecommunications | 34 | National Starch and Chemical | 11 | Yamanouchi | 22 |
| Flow Systems | 9 | Nelson Industries | 41 | Zetron | 35 |
| Focus Research | 44 | Niagara Mohawk Power | 42 | Zitel | 58 |
| Fritzsche, Pambianchi & Associates | 20 | Nochange Software | 55 | Zurich Mobile Imports | 64 |
| Fujitsu | 15 | Noise Cancellation Technologies | 41 | ZymoGenetics | 20 |

Business Behind the Wheel

AUTO

Keeping both hands on the wheel

A NEW steering wheel lets drivers make phone calls or change radio stations without taking their eyes off the road.

The wheel, designed by the Swiss company Rinspeed, has buttons that control 20 functions for cellular telephones and audio equipment made by Blaupunkt, AudioVox, and Kenwood. Instead of wires, the wheel uses an infrared transmitter to send commands to a control module mounted behind the dashboard. Rinspeed plans to add a speaker phone, an answering machine, a dictation system, and cruise control sometime this year.

The product's official name is the Perfect Touch Command Center; it costs about \$1,000. Zurich Mobile Imports of Laguna Hills, Calif., manufactures the wheel and supplies it to several car makers, including General Motors and Honda. The product is also available to car owners through Blaupunkt distributors.

—Jennifer Christensen

HOME

Sensors turn on taps

AN AUTOMATIC faucet that uses beams of light to turn itself on and off



Steering wheel command center helps keep cars on the road.

should help save water and make life easier.

The faucet, made by Tandem Enterprises, emits two beams of infrared light from its base—one beam for hot water, the other for cold. When a hand passes through the beams, light reflects back to sensors that trigger tiny electric motors to turn on the tap. Water also flows with a push of the faucet to the left, so the faucet will work even during a power blackout.

Tandem says the faucet will help elderly or handicapped people, who may have trouble turning a conventional faucet knob. The tap also saves water by turning off when the beam indicates a continuous flow of water is not needed—when brushing teeth, for example. However, the faucet runs at only one rate; the user cannot adjust the flow.

Installation takes 45 min-

utes, according to Tandem. The \$119.95 device should be available in stores late this year. Tandem Enterprises is located at 27 Teele Drive, Coram, NY 11727. Telephone (516) 736-2533.

—Elizabeth Aaron

HOME

Speakers to sit on

FILM buffs who like to be in the middle of the action should enjoy the Bodysonic chair from Pioneer Electronics. The chair connects to a television or stereo system to provide both the sound and the feel of a program, motion picture, or song.

The \$2,000 leather swivel

chair has two adjustable three-inch speakers on its headrest for stereo sound. A bass speaker mounted in the seat delivers low-frequency rumbles that the sitter can't hear but can feel. The chair hooks up to a TV, VCR, compact-disc player, Walkman, or boom box, and also to a surround-sound processor—an amplifier that distributes certain movie soundtracks to various speakers that encircle the listener. A hand-held remote controller linked to a stereo amplifier beneath the chair lets the user control the level of low-frequency vibration, turn the surround-sound on and off, and soften sound by filtering out high frequencies.

Pioneer is located at 2265 East 220th Street, Long Beach, CA 90801. Telephone (213) 835-6177.

—Kenan Woods



Sound placement for listeners.

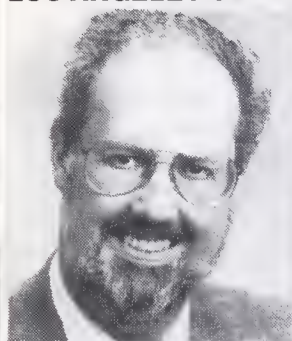
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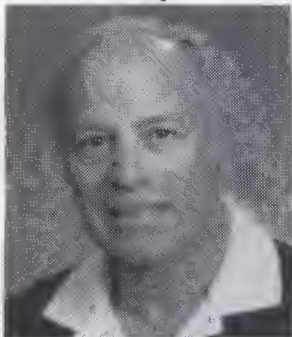
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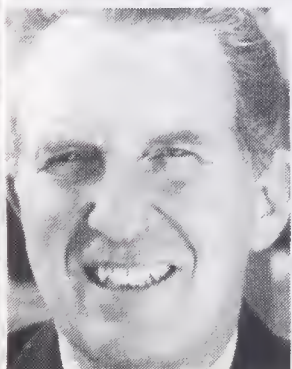
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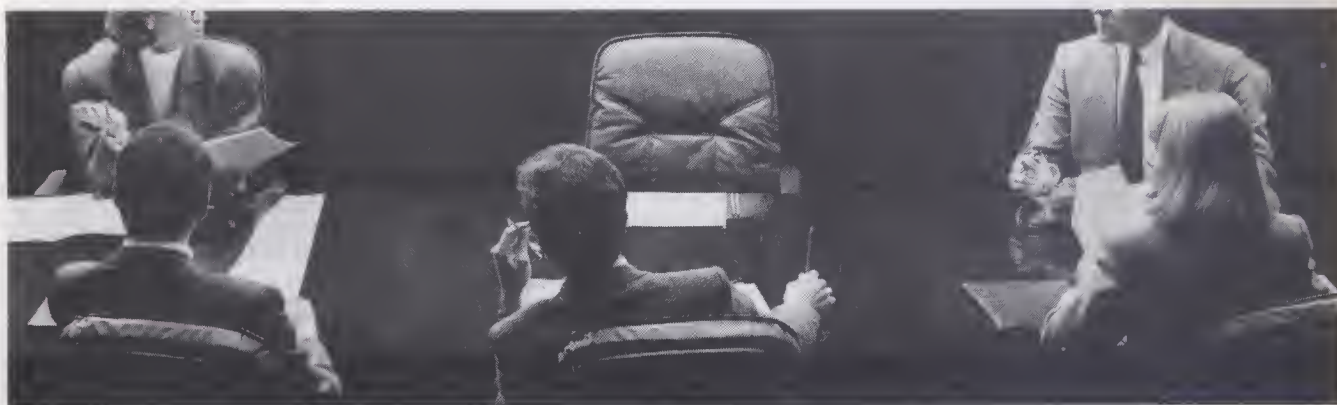
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